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# EDUCATION

VOLUME 73 — No. 7

*"Again and again, those who employ scientists point out that the people they need most are those who are willing to go beyond the book . . . formulators, not followers of formulas."—Poshay.*

Will Your Major Support You?

Some Facts on the Current Shortage of Technical Personnel

Reference Material on Guidance

Guidance Toward Engineering

Guidance Toward Research and Development in Physics

Guidance Toward Chemical and Engineering and Research

Guidance Toward Biological Vocations

Outdoor Education is a Profession

Foundations for Guidance Toward Science

Some Notes on Science and Guidance

Supervision of Guidance Toward Science

A High School Teacher's Opportunities for Guidance Toward Science

Science Careers of 1968

Guidance Toward Science Teaching

The Early Guidance of Scientific Interest

Guidance Toward Electronics Research and Development

Good Advice

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A MAGAZINE DEVOTED *to the* SCIENCE, ART, PHILOSOPHY *and* LITERATURE *of* EDUCATION

# EDUCATION


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# EDUCATION

A MONTHLY MAGAZINE

DEVOTED TO THE SCIENCE, ART, PHILOSOPHY AND LITERATURE OF EDUCATION

VOL. 73 MARCH, 1953 No. 7

## SCIENCE EDUCATION NUMBER

HANOR A. WEBB, *Editor*

Department of Science Education
George Peabody College for Teachers

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***Foreword by Robert J. Havighurst, Professor of Education, University of Chicago***

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# EDUCATION

Vol. 73 MARCH, 1953 No. 7

*"Every young person who has been led into a blind alley by higher education deserved better guidance."—Webb.*

# Will Your Major Support You?

*By* HANOR A. WEBB

*Department of Science Education*
*George Peabody College for Teachers, Nashville, Tennessee*

THE young lady was no longer a stranger. My grandfatherly mien and expressed interest invited confidence—so she was telling of her ambitions. Her radiance fascinated me—reminding me, of course, of my own beauteous daughters at her age. We had introduced ourselves across a dining-car table as the New York Central train rushed eastward. It was the start of the Christmas holidays.

"I'm majoring in Criminology," she told me, "at . . . . State University—and it's wonderful! The professor is young, and he's divine!"

"Has the professor had much experience as—er—ah—as a criminal?" I asked. She froze—looked out of the window.

"Please don't misunderstand," I apologized. "I mean, how did your professor get his expert knowledge of crime?"

"He quotes all the best authorities, and tells us of the trials he has attended. He takes us on field trips, too!"

"Where do you go on these field trips?" This I *really* wanted to know.

"We have been to the courts and once we went to the jail. And oh!"—her enthusiasm had returned—"oh, there we met wonderful young men, all so misunderstood, so anxious to be honest if they can only be released. One of them with brown eyes and curly hair . . ."

Enthusiasm—it is wonderful! Finally I asked, "Will Criminology help you make a living next year after you graduate? Your major should support you, you know!"

"Oh, it will—indeed it will!" The happy prospect was all worked out. "I expect to work with young men who have gone astray, and lead them . . ."

I did not utter what was in my heart—"it is unthinkable that such charm be wasted on the undeserving! My sincere hope is that with little delay the leading will be done by some wholly worthy young man, and up the aisle away from a flowery altar. Then I hope . . ." But I did speak my earnest good wishes for her pleasant journey home, and a cheerful return to the University in January.

This was not the first—nor the last

—occasion of my inquiry of some young college student, "Will your major support you?" Among those I remember was a young lady who dug among the ruins of the Southwest as a major in Archeology, but has earned every dollar since in a library. A young man asked my counsel after his major professor frankly told him, "A psychologist without a Ph. D. can't make a dime! If you really can't finance a doctorate, start over." A frightened girl asked advice in this predicament: "I must teach next fall—my dad has died. I will finish my Bachelor's next month, with a major in Philosophy. Where can I teach philosophy? What can I do?"

Will your major support you? In answering this question as a counselor, I have nothing against majors in Social Studies—except the question as to how one makes a living at 22 as an historian. Astronomy is a wonderful field—but though the amateurs are many, the professionals are few. Comparative Religion is stimulating—but do you have a "call to preach?" Sociology deals with practical problems—but are you ready to start walking the rounds of the social worker?

Every young person who has been led into a blind alley by higher education deserved better guidance than he received. I believe that in this Age of Science there should be early discovery and effective guidance, of any talent for science that is latent in a boy or girl. Scientific knowledge, always satisfying, may be quite rewarding.

It has seemed appropriate, therefore, to devote this entire issue of Education to the theme of guidance toward scientific occupations. Specialists of experience present the different fields —for science is indeed diversified. As we read these articles we will find the responsibilities of science teachers for guidance emphasized. There is something holy about this responsibility—a certain gift to society which the science teacher has been ordained to make. May each of us be good and faithful servants in this matter.

*"Dr. DuBridge [President, California Institute of Technology] urged active participation by members of the Institute [of Radio Engineers] in campaigns to stimulate interest in engineering, particularly at the high school level, . . ." Astin*

# Some Facts *on the* Current Shortage *of* Technical Personnel

*By* A. V. ASTIN

*Director, National Bureau of Standards, Washington, D. C.*

ONE OF the most striking and important indications of the acuteness of the current shortage of technical personnel, and its importance to our national welfare, is a recent policy statement of the Office of Defense Mobilization. This organization is charged with the direction, control, and coordination, on behalf of the President, of all mobilization activities of the Government, including production, procurement, manpower stabilization and transportation. This policy statement is (in part) as follows: "The importance of scientists and engineers in the establishment of the strongest possible defense and, should war come, in insuring ultimate victory is well established and widely recognized. Furthermore, there is no limit in principle to the advances which can be made in science and technology, practical limits being imposed largely by the limited number of individuals with training and ability along these lines. The problem then is to formulate national policies and to take actions consistent with those policies and with principles of a voluntary manpower program in order to guarantee the most effective use of existing resources of scientific and technical personnel, and to encourage the training of increasing numbers of additional scientists and engineers."

The Office of Defense Mobilization makes several recommendations. First, it outlines instructions to Government agencies to plan programs for the utilization of specialists within the framework of the present shortage; second, it urges schools, employers and Government departments to stimulate the education of engineers and scientists. And, third, it asks industry to provide both on-the-job and off-the-job schools to develop sub-professional personnel to do work which requires less than fully trained scientists and engineers. This far-reaching recognition of the problem by the country's top defense mobilization agency established very definitely the urgency and importance of the problem. There are however, supporting data from many other sources—for example, from the National Science Foundation and the National Research Council.

The great shortage of engineers has been stated and documented in a clear and unambiguous manner by many of the country's leading experts— for example, K. T. Compton, Chairman of the Corporation of the Massachusetts

* The substance of this paper is based on an address, "The Need for Scientific Talent," delivered before the Southern Regional Conference of the National Science Teachers Association, Atlanta, Georgia, October 14, 1952.

Institute of Technology in the Sept., 1951, issue of the Scientific American; Lee DuBridge, President of the California Institute of Technology in the Aug., 1952, Proceedings of the Institute of Radio Engineers; and S. C. Hollister, Dean of Engineering at Cornell University and President of the American Institute of Electrical Engineers at the Institute's 1952 Convention. A consensus of their concurrent statements shows that there are now about 400,000 engineers in this country; there is a current shortage of engineers of somewhere between 80,000 and 100,000. Normal attrition and regular expansion in the engineering fields requires an annual influx of new engineers of at least 30,000, and the estimated graduation by the colleges of new engineers for the next few years is less than 20,000 per year. Of these new graduates probably one-half or more are R.O.T.C. students and will not be immediately available for the pressing needs of the engineering industries.

From these figures it is obvious that there is no immediate hope of reducing the present shortage. There is an almost inevitable certainty that it will increase by at least 10,000 to 20,000 men per year! In speaking to the Los Angeles section of the Institute of Radio Engineers on this subject, Dr. DuBridge urged that the members of the Institute assume individual and collective responsibility for doing something about this problem, and suggested active participation by the members in campaigns to stimulate interest in engineering, particularly at the high school level, and also to attempt to raise funds for scholarships so that financial incentive could be provided to those who need it in order to obtain engineering educations.

At the annual meeting of the American Chemical Society (September, 1952) appreciable attention was given to the short supply of chemists. The results of a survey completed by the Society showed a decrease in the graduation of chemists by the colleges from nearly 11,000 bachelors in 1950 to about 7,400 in 1952 and an estimated 5,000 in 1955! The Society urged all local sections to initiate "grass roots" campaigns to stimulate interest in careers in chemistry through local meetings, through the use of television and by cooperation with and support to the high schools.

The last annual report of the American Institute of Physics was concerned largely with various phases of the short supply of physicists and the increasing demands for physicists. A significant illustration of the short supply in this area is shown by the competition for physicists at the meeting of the American Institute of Physics in Chicago last fall. At this meeting the Institute's placement register recorded 201 registrants, only 4 of whom were actually unemployed, and there were over 800 positions to be filled! Although the figures cannot be construed as representing the situation for the country as a whole, the ratio in this instance highlights sharply the seriousness of the situation.

The recruitment picture is probably one of the most convincing ways in which the shortage can be demonstrated. One has merely to read the classified ads in any of the professional society journals or in some of the large metropolitan newspapers to realize that the demand for scientists far ex-

ceeds the supply. In one midwestern college it was estimated that each graduating engineer was approached on an average of 7 times with offers of prospective employment. A few of the leading members of the class had upwards of *20* interviews! It would appear that engineering graduates are no longer interviewed by employers but rather the students are interviewing their prospective bosses! Figures from a recent meeting of the Mid-West College Placement Association, representing experiences of 39 leading industrial organizations, showed that all 39 companies interviewed on the average at least 5 prospective students for each one hired. A third of the companies interviewed approximately 20 prospective applicants or more for each position filled.

A pertinent example of the recruitment pictures is provided by the experience this past spring of one of the organizational units in the National Bureau of Standards. This unit was engaged in a very urgent weapons development program which required a rapid expansion of its technical personnel complement. The recruiting team conducted over 1,000 individual interviews. Four hundred eighty-five interested students submitted formal applications for employment. The Bureau's technical staff selected 107 of these applicants as suitable for employment and made specific offers to them. Twenty-two of these offers were accepted. This represents an acceptance ratio of about 20% and an effective interview efficiency of only slightly better than 2%!

All government laboratories and technical agencies are deeply concerned with recruitment problems, in attempting to meet their current responsibilities in the country's defense program. The number of scientists and engineers employed by various government laboratories increased about ten per cent from 1951 to 1952. This goal was not attained without the expenditure of considerable effort. In order to provide suggestions and guidance on efficient and effective recruitment techniques the Government's Interdepartmental Committee on Scientific Research and Development has studied the problem carefully and made valuable suggestions to the individual agencies.

The shortage of scientists is a problem not only in this country but in other places as well. The British, for example, have been giving the matter very serious attention. Their Advisory Council on Scientific Policy in its report to the Parliament in May, 1952, presented the following conclusions; "There is a pressing need to increase both absolutely and relatively the number of scientists in our industries. There is an increasing trend toward their employment in managerial and executive posts. The momentum within this trend is likely to gather strength. There is likely to be a long-range shortage of practically all kinds of scientists; every effort should be made to increase the supply with particular emphasis on chemists, chemical engineers, electrical engineers, mechanical engineers, and physicists."

The examples just presented establish very definitely the fact that there is a current serious and unfilled need for scientists and engineers. It is particularly important for members of the National Science Teachers Association to appraise the durability and permanence of this need. High school stu-

dents electing to make a career in science have before them a minimum of 4 years and in some instances 8 to 10 years of intensive educational training before they become productive scientists. Hence, the impact of any effort on the part of high school science teachers to direct more of their students into scientific careers will not be felt for many years.

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# Reference Material *on* Guidance

THE CURRENT material on the guidance of young people in the schools is voluminous. Further reading and study may be carried out in any library. Consult—

For Books: *Cumulative Book Index* (monthly issues), topics of Guidance.

For periodicals: The topics of Educational Guidance and of Vocational Guidance in *Agricultural Index, Education Index, Industrial Arts Index, International Index to Periodicals, Readers' Guide to Periodical Literature.*

For brochures and bulletins: Alert librarians and teachers may obtain much material from industrial sources. Typical are these:

American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C., "The Chemical Profession—an Educational and Vocational Guidance Pamphlet," 25 cents; "Careers in Chemistry and Chemical Engineering," reprints of twenty-nine specific articles from *Chemical and Engineering News,* $1.00.

Engineers' Council for Professional Development, 29 West Thirty-ninth St., New York, N. Y., "Engineering as a Career" (with bibliography), 15 cents.

General Motors Corporation, Detroit 2, Mich., "Can I Be An Engineer," free from Department of Public Relations.

National Association of Manufacturers, 14 West 49 St., New York 20, N. Y., "Your Opportunities in Science," free. Profusely illustrated; copies available in class quantity.

Vocational Guidance Manuals, 45 West 45th St., New York 19, N. Y.; publishers of an extensive series of "Opportunities in . . .," with constant additions. Typical of science, "Opportunities in the Petroleum Industry. Price, 85 cents each plus postage. Send for complete list of Manuals.

Women's Bureau, U. S. Department of Labor, Bulletin No. 223, 1948-9, in eight parts: 223-1, "The Outlook for Women in Science," 20¢; 223-2 "The Outlook for Women in Chemistry," 20¢; 223-3, "The Outlook for Women in the Biological Sciences," 25¢; 223-4, "The Outlook for Women in Mathematics and Statistics," 10¢; 223-5, "The Outlook for Women in Architecture and Engineering," 25¢; 223-6, "The Outlook for Women in Physics and Astronomy," 15¢; 223-7, "The Outlook for Women in Geology, Geography, and Meteorology," 15¢; 223-8, "The Outlook for Women in Occupations Related to Science," 15¢.

The sources mentioned may have other bulletins available; request should be made for this information.

*"The engineer is a creator. He contributes to true social progress . . . . The past record, however great, is bound to be surpassed in the future by even greater achievements and opportunities created by engineers."—McWilliams.*

# Guidance Toward Engineering

*By* R. L. McWILLIAMS

*Educational Relations Section, Public Relations Department, General Motors Corporation, Detroit*

The heights by great men reached and kept
Were not attained by sudden flight
But they, while their companions slept,
Were toiling upward in the night.
—*Longfellow.*

PERHAPS the greatest single contribution a counselor can make to help a youngster select a career is to make him understand the above sentiment. Successful men in all walks of life have always made a little more effort, held a little more devotion, and have to a greater degree enjoyed their chosen field than have those dissatisfied with their own progress.

Whichever the individual chooses of the many careers—economics, law, medicine, engineering, or some other—the basic requirements of willingness to work and enjoyment of the effort are the foremost essentials. Every career requires hard work. Engineering as a career is no exception.

This article attempts to discuss engineering objectively from viewpoints which may help those who place a youngster's feet on the path to a lifetime productive career. Five subtopics have been chosen which may be helpful to the counselor in evaluating the question "Can I Be An Engineer?" They answer these questions: What is the present requirement for engineers? What is the future requirement? Who can be an engineer? What are the rewards of an engineer? What education is required for one who would be an engineer?

Currently the demand for individuals trained as engineers greatly exceeds the supply. The large classes which graduated in 1949, '50, '51, and '52 fell far short of filling the requirements of industry and the armed forces. The graduating classes for the next few years also are estimated to be seriously fewer in number than the available jobs. In fact the current shortage of engineers is one of our most critical problems and will require wise use of our present engineering talent. Today each industry is making every effort to see that engineers in their employ are utilized in the most efficient application of the engineer's talent. In times of material shortages engineers can "make do" in many ways. However, there is no substitute for an engineer.

Although the Freshman Class which started in the Fall of 1952 shows marked increase in the number of engineering students, the current shortage is very likely to be with us for some time to come. In retrospect the causes

for this alarming shortage are debatable. Without attempting to point to any single factor here are a few which contributed. They are cited primarily as factors which must be weighed in attempting to forecast futures.

Perhaps the most tangible cause, but not the most important, was the announcement from a report by the Department of Labor, in 1949, which indicated an oversupply of engineers in the immediate future. Enrollment in Engineering Schools suffered a drastic drop in the following year. The drop in enrollment may have been the effect of the wide spread distribution of that announcement to schools and vocational advisors. It may also have been due to a return to "normal" after the abnormally large classes in the post war years. However, the full report indicated very conclusively the past increase in ratio of engineers to workers and forecasted a continuance of this increase which quite reasonably might reach a requirement for twice as many engineering graduates per year as in the decade from 1930-1940. (Employment Outlook For Engineers, Occupational Outlook Series, Bull. 968 of Bureau of Labor Statistics). As we know now, the estimated excess of engineering graduates never materialized.

The Engineering graduate is the product of essentially a four year cycle. Therefore, the abnormally large (by 1940 standards) graduating classes of engineers in 1949, '50, and '51 were the result of the swollen enrollment of the years immediately following World War II. These classes probably may be said to have made up the attrition and lack of enrollments only during the war years. Abrupt dislocation of normal trends also create havoc particularly on relatively long cycles. The sudden conversion into a "dual economy" with the onset of the Korean hostilities in 1950 was a condition which the four year engineering graduate cycle could not meet. To this situation also can be charged some of the cause of our engineer shortage. The effect of the large post war business expansion and Korea was not measurable when the study which indicated a possible temporary supply of engineers was made.

A quantitative answer to the question "What is the future requirement for engineers?" is of little definite value. Events and conditions change too rapidly and the future is too veiled. However, a quantitative look at the past and a consideration of the present and future leads to but one conclusion. The current output of engineers is not sufficient. Both the general population and the percent of engineers in the total population are increasing. The number of engineers per 100,000 workers is increasing much more rapidly, however, than the population. As the population was multiplied nearly two and one-half times between 1890 and 1950, the number of engineers increased four and one-half times.

There are several reasons for this growth in the proportion of engineers. The change from a rural economy to a manufacturing economy is one of them. An economy that expands to meet normal population growth is another. Of greater influence than these too, however, has been the increasing complexity of our machines and equipment. Each new development of the period mentioned (1890-1950) was on a higher technical level. As a result each new development required an increase in engineering manpower for the higher the technical level is the more addi-

tional engineering must be applied to raise it further; the higher the technical level is the more engineering talent is required to maintain it.

We are in a period of sharply rising technological level. The post war business expansion and replacement has brought along new developments in machine tools and manufacturing processes. Discussion is prevalent on "Automation," the push-button factory. Even the trends, spotty as they are, towards this area of technology forecast an even greater ratio of engineers to workers. In addition to the rising technical level in tools and products we have the problem of engineering our "catching up." In highways, housing, utilities, and in many other fields construction has not kept pace with our population growth during most of the past twenty years or so.

In consideration of the proven constant increase in ratio of engineers to workers and the current and definite future upward curve of our technological level, today's output of engineering graduates in all fields is not sufficient. More students should enter engineering careers and the survival rates should somehow be improved without reducing the quality of engineers to insure the higher number of graduates required.

It is quite difficult, if not impossible, to forecast the engineer requirements on a basis of specific fields of engineering. In many respects the training given civil, mechanical, electrical, chemical and other engineers is such that adapting from one field or another is not overly difficult. In fact if five major classes are considered mining and metallurgical, civil, mechanical, chemical and electrical engineering, a relatively high percentage of engineers in those classes are not working in the field of their major training. This percentage in 1948 varied from 15% of mechanical engineers to 27% of mining and metallurgical engineers not working in the field of engineering of their scholastic training.

Assuming that the condition of a current shortage of engineers exists has been established and that the situation will continue unless sharply increased enrollment in engineering schools occurs, what about the other three topics mentioned in the introduction: Who can be an engineer? Rewards to the engineer, and Education of one who would be an engineer.

Not everyone can be an engineer. Aptitude is an important factor. It is difficult to forecast in which of the many fields a student will do his best work. Good aptitude testing is fairly reliable although usually not available. However, very rough guides do exist which may indicate a student's aptitude. These guides to a student's interest and ability in engineering are usually a liking to work with mechanical things, a desire to know why things work as well as how, and an interest in reading about scientific subjects. He does good work in his mathematics and science courses. Such a student usually posseses a fairly high degree of manual dexterity, and his hobbies are the building of model cars, planes, and other "creative" projects.

Although the student who meets these rough guides will very likely do well in engineering some of our best engineers did not have these early indications. However, the present excellent opportunities for the engineering student should not be used to urge stu-

dents into that field who may show tendencies, though slight, for other careers. Miscasting leads only to blighted careers and is partially responsible for the dropouts and failures during the school years.

Any student who desires to enter college should by all means be encouraged to do so. All statistics point to the increased earning capacity of the trained individual. In a large sense financial problems should prove no real barrier. Most all colleges have scholarships available as well as loan funds from which the deserving student can obtain help. This in addition to part time work can often help over what seems an unsurmountable obstacle. In these times of a serious shortage of engineers all other likely avenues of available aid to deserving students should be explored.

After the college years the rewards to an engineer are twofold. The engineer is a creator. As such he contributes to true social progress. The marvelous devices we have today have been created by the engineer and his work has the true ring of progress. The past record of engineering achievements and opportunities, however great, is bound to be surpassed in the future by even greater achievements and opportunities created by engineers.

The second reward to the engineer is that measured by his income and responsibilities. Engineering training is not an automatic guarantee to success as so measured. It is up to the individual to climb the ladder by his own efforts. At the present time the average engineering graduate is getting a job with large companies at a salary ranging from $300 to 400 per month, and past experience indicates that engineering training plus hard work leads to real success. A note of caution should be mentioned here, however. Studies of average salaries can be misleading. As in all professions there are greater numbers at the lower incomes which effect the average and do not show the top which can be reached, but by and large the engineering profession is perhaps one of the best paid major professions in this country.

Engineers because of their training often enter other fields such as sales, advertising, personnel, and other lines. Not only the technical knowledge helps them, but also the thinking habits and methods of analyzing a problem that become second nature to an engineer. Such training often leads the engineer into management jobs. A recent survey found that 40 percent of the top jobs in industry are now held by men with engineering training.

College entrance requirements for courses leading to engineering careers are fairly uniform. The fields of engineering overlap, and the same high school preparation will do for all of them. In fact the junior year in college is often the first year of special study for a particular branch of engineering. For this reason the choice of a specific engineering career during high school years is of secondary importance.

During high school the student will study many courses required for all professions. These courses also help to prepare him for living in today's world. However, a sound foundation for engineering will include all the mathematics possible; science, at least chemistry or physics and preferably both; but not at the expense of English, history or social studies.

In conclusion the counselor can

point out to the student the rich material and spiritual rewards in the fields of engineering, and the expanding need for trained men if our nation's program is to continue. The student should assert his true interest in engineering and the willingness to work hard to attain his goal. This can be done by building a sound foundation in the basic mathematics and science courses together with languages, history, and social studies which give breadth and understanding necessary to true success.

## BOOK REVIEWS

**Makers of Modern Science.** A Twentieth Century Library Trilogy. New York. Charles Scribner's Sons. 1953. $4.00.

Three of the pioneers of modern science are the subjects of the essays that comprise this volume. The first is Charles Darwin whose career is traced by Paul B. Sears. Gregory Zilboorg is the biographer of the second, Sigmund Freud, while Leopold Infeld discusses Albert Einstein in the third story. The essays have been prepared for the intelligent layman rather than for the specialist and in each case the presentation is of great clarity. The dynamic personalities of these three scientists and their influence in their respective fields are carefully brought out by each of the authors.—WILLIAM P. SEARS.

**Living Things.** By Frederick L. Fitzpatrick and Thomas D. Bain. New York. Henry Holt and Company. 1953. $3.60.

*Living Things* is presented as a text in general biology for high school students. The authors have been careful to select material that is meaningful to young people and useful to them in everyday life. The approach is to the average student of the secondary school and the presentation, together with the suggested activities, should challenge these young people. The book is organized into eight units which are broken up into topics. These topics, in turn, are made up into chapters. At the end of each chapter, there is a group of short-answer items. Scientific words used for the first time are defined at the beginning of each topic while at the end of these topics there are summaries, lists of scientific terms, questions which emphasize applications to human problems, and suggestions for field trips and a variety of other learning experiences.—WILLIAM P. SEARS.

**The World of Eli Whitney.** By Jeanette Mirsky and Allan Nevins. New York. The Macmillan Company. 1952. $5.75.

To Americans, the name of Eli Whitney is invariably associated with the cotton gin. To be sure, this Yankee school master invented the contrivance that had so much to do with the course of development of the planter's economy of the early nineteenth century, but the influence of the man in the history of America's industrial evolution rests upon the development of a very fundamental principle. It was Whitney's development of standard interchangeable parts that solved the problem of the production of muskets in his brother's fire arms plant and that prepared the way for the evolution of the mass production methods that have characterized American industry. The authors of this revealing biography have had access to the collection of Whitney papers now in the custody of the Yale University Library and presented to that institution by the inventor's great-grand daughters. Whitney's inventions were indeed revolutionary and his influence on our industrial history far-reaching. The story of his life and his work is very interesting reading and basic to an understanding of our industrial growth.—WILLIAM P. SEARS, New York University.

**Physics for Modern Times.** By Abraham Marcus. New York. Prentice-Hall, Inc. 1952. $3.92.

This is a complete, modern and comprehensive text in physics for high school students. The author is a teacher in one of the New York City high schools and has had wide experience in the various fields of physics and in text book writing. The approach is from the cultural point of view and physics is conceived of as vital to life in our present world.—WILLIAM P. SEARS, New York University.

*"The upper elementary, junior high school, and senior high school years are critical for the discovery and guidance of our future physicists."—Wilson.*

# Guidance Toward Research *and* Development *in* Physics

*By* LELAND L. WILSON

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*Do We Need More Physicists?*

MOST OF THE basic advances in our knowledge of physics since its beginning as an experimental science have come from outside the United States. A survey of the field from Galileo to Einstein will show that Europeans have contributed most to pure research in physics. Research work of outstanding significance has been done by American physicists, particularly in recent years, yet our greatest accomplishments in physics have been in the developmental field. We have taken the discoveries of others, applied them in practical ways, and produced the greatest industrial machine on earth.

We can no longer depend upon nations which have been improverished by war for the basic research to nourish our technology. Americans must give more attention to pure research in physics and other sciences if we are to maintain our technological leadership in the world.

A look at the advertisements in any scientific journal is sufficient evidence of our present shortage of physicists. Business concerns of all types are competing for those trained to do research work in physics. We have approximately 12,000 physicists in this country, including 3,500 Ph.D.'s, according to figures recently released by M. H. Trytten, Director of the Office of Scientific Personnel of the National Research Council. Of this number 4,000 are employed in educational institutions, 3,500 in governmental agencies, and 4,500 in industry. Figures recently compiled by Dr. Marsh W. White of the Pennsylvania State College shows that undergraduate enrollment of physics majors reached a peak of about 12,500 in 1949-50 and has now dropped to around 10,000. The enrollment of graduate students in physics rose sharply after World War II, but has now leveled off at slightly less than 6,000.

Our present shortage of physicists, which is not due altogther to the international tension, is not likely to be erased soon. The very nature of science will cause the demand for physicists to increase as we have expansion in such fields as electronics, nuclear physics, and quantum theory. The shortage in pure research will be more acute than in developmental work. Dr. Trytten has also pointed out that relatively few graduates in science are choosing academic careers and pure research because of the great discrepancy between salaries paid by the Universities and those paid in government and industry.

We need more physicists, particularly in pure research work. Our ability to meet this need will depend to a large extent upon what teachers do to encourage those students who have the potentital ability for creative work in science.

### *Finding Potential Physicists*

The first step in guidance toward this specialized occupation of research in physics is to find the youngsters with the necessary traits for success in such work. What are the qualities to look for?

Intelligence well above average is necessary for the mastery of the skills and concepts involved in physics research work, although it is not sufficient in itself. Intelligence tests will enable us to identify those of superior intellectual ability. We should be using these tests, if for no other purpose than to discover those of outstanding promise, not only in science but in other fields as well.

Scientific curiosity and interest are certainly necessary for a potential physicist. These traits may be discovered by careful observation of student's reading, use of spare time, and reactions to science experiences in the classroom. Good science teaching will help to develop curiosity and interest in science.

Originality and creative imagination are indeed rare, but they are fundamental to research in any field. The student who thinks of original explanations for natural phenomena and devises experiments and equipment for himself is likely to be gifted with these qualities in some measure and should be encouraged. All too often teachers, harassed by classroom details, succumb to the temptation to discourage originality because to encourage it would involve more time-consuming work.

Mathematics is an essential tool for any advanced work in physics. Therefore, aptitude for mathematics is another essential trait which we should look for in the potential physicist. Reliable aptitude tests for various areas are now available and should definitely be used in guidance toward research in physics.

Skill in the manipulation of tools and apparatus is also a desirable ability for the physicist. Such skill can be developed to a considerable extent, but some natural facility is desirable for the experimental physicist.

There are many other qualities which will contribute to success in physics research work as they will in any other profession. Among these are self-confidence, initiative, reliability, patience, cooperation, and that elusive something which we call character.

We will not find all the traits listed here developed to a high degree in many students. However, when we find an unusual combination of these qualities which add up to what we call scientific aptitude, we should do something about it. The student should be encouraged to go as far and as fast in science as he can, and his parents should be advised of his potentialities. We have been so engrossed with the educational problems of the average and the retarded that we have given too little attention to the development of superior talent.

### *How May We Guide Capable Students Toward Research in Physics?*

Effective guidance of students with scientific ability should start early. Interests which last a lifetime are developed at an early age. Herbert S. Zim,

in a study of science-talented young men and women, found the average age of first interest in science was between 10 and 11 years. Dr. Zim, in a further study of scientists at the University of Illinois found that 364 out of 529, or 69%, chose their present vocation by the age of 18. The upper elementary, junior high school, and senior high school years are critical for the discovery and guidance of our future physicists.

Perhaps the most important single thing which any teacher can do for potentially good science students is to make science vitally interesting in the classroom. A science class accompanied by student and teacher planning and conducted in an atmosphere of exploration and adventure can be a powerful interest stimulant. Physics enrollment in American High Schools has been declining for a good many years and the subject is being dropped by many. Less than 60 per cent of all high school students in the United States studied any science during the school year of 1949. Could it be that some of this lack of interest in science is due to our failure as teachers to make it interesting and challenging to students?

Our potential physicists should have ample opportunity to use their originality. Simple research projects should start as early as the student desires. Anna Roe, in an extensive study of 64 eminent American scientists, including 22 physicists, found that one of the most important factors in the final decision to become a scientist was the discovery of satisfaction in doing research. The implication of this fact for our science teaching should be obvious. Assignment as student assistants to help in the preparation and presentation of experiments and demonstrations will give our exceptional students desirable experience.

The physicist must also be a citizen, and he needs knowledge and understanding in fields other than his specialty. Our future physicists should be guided wisely in this respect. We should not, in our enthusiasm for science and mathematics, overlook the importance of such areas as language, social studies, and the arts for these students.

A science club is an excellent means for the discovery and development of originality and interests in science. An active club will give students an opportunity to work on projects of their own choosing and to engage in elementary research. Our future physicists may very well discover here the satisfactions of research and thus be motivated along the road of preparation for research work in physics.

Science talent searches on both national and state levels offer opportunities to promising students of science. These programs seek to discover those with ability for creative research, to give them recognition, and to provide financial aid toward college training in science.

The twelfth annual Science Talent Search, sponsored by the Westinghouse Educational Foundation, is now coming to a close. The winners of scholarships totalling eleven thousand dollars have been determined by a science aptitude examination, personal data from teachers, a report on a scientific project, and interviews with the judging committee. The success of this project in discovering and encouraging young scientists is shown by the record of 440 previous winners, all of whom

are still under 29 years of age. Their degrees total 257 bachelors, 64 masters, and 40 doctors. A total of 85 are now holding full time positions as scientists. More of these science talent search winners have chosen careers in physics than in any other science.

The Future Scientists of America Foundation, sponsored by the National Science Teachers Association in cooperation with The American Society for Metals, has recently launched an extensive program of science achievement awards for those students who are the future scientists of America. This program is designed to stimulate and recognize superior work in experimental science by both junior and senior high school students.

Alert teachers will direct the attention of their superior science students to these nationwide activities and to similar ones on the state or local level. Junior academies of science are growing over the nation and are sponsoring many worthwhile activities. These activities will help us to discover and develop our potential research physicists.

We need more physicists now and will continue to need them in the years ahead. Teachers in the elementary and high schools are in a strategic position to help meet this need by finding those with the necessary talent and guiding them in the right direction. This effort is worthy of our attention not only because our nation needs these trained specialists, but because it will mean much to the happiness of those whom we help toward a satisfying and worthwhile life work.

*"People who score high on the theoretical [research] value are interested in the search for truth. They want to know what makes the world go around, and they are eternally asking 'why?'"—Murphy.*

# Guidance Toward Chemical Engineering *and* Research

*By* WALTER J. MURPHY

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LEADERS of the chemical profession and the chemical industry currently are disturbed by the shortage of young men and women training for careers in chemistry and chemical engineering. The chemical industry has demonstrated over the past 25 years that it is definitely a growth industry. Indeed, curves show the chemical field has been expanding more than three times faster than industry generally. Therefore, the need for chemists and chemical engineers can be expected to expand indefinitely unless, of course, there is a serious and prolonged recession or depression which would force curtailment in research and in the manufacture of chemicals and allied products.

Most professions are concerned with downward trends in enrollment. The reasons are many and varied—the low birth rate of the '30's, the international situation, and the comparatively high wages paid skilled and unskilled labor. There is no question but what wages of labor have increased faster than salaries paid in most professions. To many youths, a college education does not seem attractive under present day conditions.

There is a great challenge in the chemical industry and in fundamental and applied research for many youngsters. The profession is interested not in large numbers but in the competency of those who enter it. For those who are competent, there are many intriguing opportunities.

What are the qualifications that one should look for in advising a youngster to undertake a career in chemistry or chemical engineering? We can answer this question by indicating the kind of instruction he will receive in a topflight school.

Dr. J. C. Warner, President of Carnegie Institute of Technology, described the ideal instruction in an article entitled, "Undergraduate Education for the Profession of Chemistry" which appeared in CHEMICAL AND ENGINEERING NEWS (Vol. 28, No. 31, July 31, 1950). Dr. Warner describes the instruction as follows:

1. Thorough and integrated understanding of fundamental knowledge and a familiarity with the basic techniques in chemistry and related fields, and the ability to use this knowledge and these basic techniques.

2. Genuine competence in the orderly way of analytical thinking which scientists and other professional men have always used in reaching sound, creative conclusions, to the end that

after graduation the student can, by such thinking, reach his own decisions in his professional work as a chemist and as a citizen.

3. Ability to learn for himself with scholarly orderliness, so that after graduation he will be able to grow in wisdom and keep abreast of the changing knowledge and problems of his profession and the society in which he lives.

4. The philosophical outlook and breadth of knowledge which will enable him to recognize and deal with the human, economic, and social problems, of his professional work.

In outlining the qualifications necessary for success in chemistry or chemical engineering, I quote from another article in the series on careers in chemistry and chemical engineering. William C. Krathwohl, Director of Tests, Institute for Psychological Services, Illinois Institute of Technology, in discussing the subject "Psychological Testing in Career Selection," *(Chemical and Engineering News*, Vol. 28, No. 28, July 10, 1950) points out that it is doubtful whether a person who is not above average in mental ability can graduate as a chemist or chemical engineer from an institution which has high standards. He further points out that youngsters who are interested in the chemical profession should show up well in such subjects as mathematics, physics, and chemistry. Actually these three subjects are basically the most important ones for engineering as well. Speed and accuracy and ability to visualize are other essential qualifications. A good vocabulary is important in any kind of occupation and is absolutely necessary in a professional field. The chemist or chemical engineer who is largely inarticulate finds it very difficult to reach responsible positions in the chemical field.

The task of advising on careers in chemistry and chemical engineering has become more complicated in the past few decades for the reason that many graduate chemists are now employed in work other than actual research or testing, and many chemical engineers work outside of chemical manufacturing plants. Today, thousands of graduate chemists and chemical engineers are employed in such fields as market development, market research, technical service, sales, advertising; and thousands more are in managerial and executive positions. Quite obviously, certain qualifications are necessary in a chemist or chemical engineer who becomes an executive, but certain vital qualifications necessary for the research chemist, need not be present in the man who is a chemically-trained executive. For example, the executive should be well-qualified in the field of mathematics but he certainly does not need to be as much of a mathematician as does a physical chemist.

Dr. Krathwohl tells us that the theoretical value is important for chemists in that it tends to separate the research man from the one who is more interested in design, development, production, or sales. People who score high on the theoretical value are interested in the search for truth. They want to know what makes the world go around, and they are eternally asking "why?" Most people don't care what makes the world go around just as long as it goes around.

Dr. Krathwohl brings out two other values important to chemists, particularly those in industry. These are the business and competitive values. A man who scores high in business val-

ues, according to Dr. Krathwohl, usually measures everything in terms of dollars and cents. A person who scores high in the competitive value is not satisfied unless he gets ahead of the other fellow. The research worker almost invariably scores very high in the theoretical value but average or low n business or competitive values.

Clearly, it is asking a great deal of a vocational guidance counselor to decide on whether a youngster measures up to all of the qualifications that have been discussed. He can, however, make a reasonable evaluation that should be extremely helpful to any serious-minded boy or girl intent upon selecting a career. Certainly, vocational guidance counselors should steer away from the chemical profession any young man or woman who does not have a strong urge to enter it, or who gives evidence of a lack of appreciation of the duties and responsibilities that fall on the shoulders of those who would call themself professional.

The unhappy chemist or chemical engineer is usually a person who recognizes that he lacks certain basic qualifications for success. Some of these individuals eventually leave the field, others struggle along, in many instances, performing the work of a technician rather than that of a scientist or technologist. Where there is considerable doubt in the mind of the vocational guidance counselor that an individual has the qualifications for success, it is better to advise against the field of chemistry or chemical engineering. To a very large extent, chemists and chemical engineers are not interchangeable in the same manner that skilled labor is. More and more chemists and chemical engineers are becoming highly specialized. Surely no one can dispute the fact that the specialist is successful as a result of his own efforts and can expect little, if any, help through collective action.

Every vocational guidance counselor, who is called upon frequently to discuss with students careers in chemistry and chemical engineering, should be equipped with a few brochures or booklets which describe the qualification necessary for success, and the kinds of positions now filled in industry, in government, in research foundations, and in our colleges and universities. The American Chemical Society publishes two booklets that are available without charge to professional guidance counselors. One is entitled "The Chemical Profession" and the other "Shall I Study Chemistry." The Society also furnishes reprints at $1.00 per copy of a series of twenty-nine articles discussing "Careers in Chemistry and Chemical Engineering."

Financial aspects of a profession are important. There are those who have such a strong urge for science, or for some other profession, that financial remuneration is of secondary and perhaps of little importance at all. In this day and age, however, most people considering a profession want to know what they may expect financially.

At the most recent American Chemical Society Employment Clearing House, conducted at the fall national meeting in Atlantic City, the median salary for beginners with a bachelor's degree was $325 per month for chemists and $343 for chemical engineers. For those with master's degrees, the figure for chemists was $384 and $390 for chemical engineers. The median salary for those with a doctorate was $512.

There are those in the chemical field who earn salaries in five figures. In most instances, such salaries are paid to chemical executives who are responsible for the operation of large chemical companies. A competent chemist or chemical engineer can expect to earn a fairly good salary once that competence has been demonstrated and a certain amount of experience gained. However, it is not a field for the individual who places great emphasis on financial return.

Those who show clear evidence of outstanding ability for research and comparatively little for managerial work, should expect to study for a doctorate. A doctorate is not at all essential for success in non-research activities within the chemical profession, although some of the best known chemical compahies today are headed by men who have received Ph.D. training.

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# CHILDREN'S BOOKS

Reviewed by PAUL ZANKOWICH
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**How the World Was Explored.** Edited by Lancelot Hogben. Prepared by Marie Neurath and J. A. Lauwerys. New York. Lothrop, Lee and Shepard. 1952. $1.50.

This book, another in the "How and Why" series, covers the whole story of exploration from the first heroes who made bridges and built crude boats down to those young Norwegians who recently sailed the balsa raft Kon-Tiki on an uncharted course across the Pacific. Emphasis is placed on New World discoveries and there is a fascinating prophecy of exploration still to come on other planets. Every story is brought vividly to life by Marie Neurath's brilliant, easy-to-understand six-color pictures. This little book will appeal to all ages. It is compact and easy to read.

**The Junior Book of Insects.** By Edwin Way Teale. New York. E. P. Dutton and Company. 1953. $3.75.

This book, first published in 1939, has enjoyed six printings. In this present and enlarged edition, it is one of the few complete books published in its field and, as such, will provide young enthusiasts with a great wealth of material. The author very adroitly leaves much for his young readers to discover for themselves and he carefully guides the paths of their research. Teachers of nature-study courses, too, will find the book an excellent introduction to entomology for interested students. The text is lucidly written, the pictures and photographs are excellent, and the material is comprehensive and up-to-date.

**The Young Scientist.** By Maitland P. Simmons. New York. Exposition Press. 1951. $3.00.

Young scientists will find this book of activities a challenging and stimulating one. The experiences suggested have been tested by extensive classroom use and they will appeal to junior high school boys and girls who are interested in science. The method adopted is the experimental one and youngsters will develop their powers of observation and purposeful thinking as they carry on the activities suggested and as they face the numerous thought-provoking questions that serve to bring out the principles and concepts of science.

*"When our class is dealing with vitamins or enzymes or hormones, do we call attention to biochemistry as a profession?"—Subarsky.*

# Guidance Toward Biological Vocations

*By* ZACHARIAH SUBARSKY

*The Bronx High School of Science, New York, N. Y.*

THE LATE Dr. Karl M. Wiegand relates how, as a freshman at Cornell University, he came to ask a question of the then-professor of pharmacy. The young student's question: "Can one make a livelihood out of the study of botany?" (At that time, botany had not yet emerged from the Department of Pharmacy.)

The professor's answer was not encouraging, but that did not faze the young man. He pursued his interest and managed not only to make a livelihood out of the study of botany, but to influence the growth at Cornell of one of the finest centers in the world for the training of paleobotanists, phytopathologists, pomologists, taxonomists, plant geneticists, and other specialists in botany.

One can, indeed make a livelihood out of the study of botany; so can one make a livelihood out of the study of histology, hematology, entomology, dendrology, microbiology, piscatology, ornithology, ecology, or animal nutrition.

Why then, does the average biologically-inclined student think only of medicine or dentistry when planning a career? Could it be that our biology teaching is at fault? Could it be that we biology teachers are overlooking opportunities to inform students of *other* biological fields in which they might find a satisfying life work? If so, is this not a grievous oversight, especially at a time when society is in dire need of all kinds of technically trained people? What can we do as biology teachers to guide students toward biological vocations?

We could incorporate some vocational guidance in our teaching—not necessarily in a separate unit, but as an integral part of our day-to-day work. When our class is dealing with vitamins or enzymes or hormones, do we call attention to biochemistry as a profession? When dealing with milk, water or meat in relation to disease, do we go out of our way to point out that dairy companies and water companies employ people to make routine biological analyses? Do we point out that meat packers employ people trained in parasitology? When studying the functions of blood, do we take occasion to point out that hospitals and diagnostic laboratories employ technicians for making routine cell-counts and blood tests? When studying nutrition, do we make pupils aware that work opportunities await them as dieticians, food chemists, and teachers of home economics? When the class is studying plant reproduction, do we go out of our way to show that the production of seeds is a great industry giving interesting and profitable employment to

thousands of workers? When the class is studying heredity, do we call attention to the vast number of people who directly or indirectly make a living in occupations related to plant and animal breeding? When the class is studying ecology and conservation, do we make the class aware that private business as well as government employs foresters, entomologists, and agronomists?

Regarding all these occupations and more, do we maintain a file for the student who "bites"—a file containing pamphlets giving educational requirements, salaries, opportunities for advancement? A number of such pamphlets from industry, government, and professional schools are listed below.

There is much, too, that can be done in extra-curricular activities to interest students and guide them into biological vocations. Motion pictures can be used to give club groups an opportunity to see people at work in jobs related to biology. Excursions can be arranged to industrial laboratories, hospital laboratories, experimental farms, breeding kennels, to see and to speak with people engaged in biological vocations. Heads of laboratories or professional schools could be invited to address "career meetings."

Many community resources can be utilized by an alert teacher to provide vocational guidance; it should not be too difficult to get the cooperation of the local dairy companies, the state agricultural department, the local health agencies. Parents are often overlooked as aids in guidance. Do we have a record of occupations of parents of our pupils, and do we make personal contacts with selected parents to explain our guidance objective? In many cases such parents will *volunteer* to make their contributions. In larger school communities it is possible to set up a directory of parent consultants to whom teachers and pupils may turn for specific information on occupations —including scientific occupations.

Industry has recently come to take an active part in assisting schools to provide vocational guidance for science-minded students. Thus the Manufacturing Chemists Association has actually set up school guidance committees in industry to assist school teachers with their curricular and extra-curricular guidance activities. These committees will furnish speakers from industry, arrange trips to industrial plants and in other ways cooperate to bring to the attention of the science-minded students the opportunities for careers in industrial laboratories and plants.

The Pittsfield (Massachusetts) High School has a permanent cooperative arrangement with a major industry in that city for the guidance of pupils enrolled in the "Technical Course." In Buffalo, New York, an enterprising high school science teacher arranged a public exhibit by several cooperating local industry concerns to enlist the interest of students in the vocational possibilities in those industries.

In summary, a very important aspect of life adjustment for the student is finding a satisfactory life work. The biology teacher can make his contribution through his daily teaching, through his influence on extra curricular activities, through his utilizing the resources of the community, and through making good use of the guidance aids offered by industry and government.

Below is but a sampling of some ma-

terials that biology teachers may find helpful in guiding students toward biological occupations.

*Employment Possibilities in the Fish and Wildlife Service*—U.S. Department of the Interior. This pamphlet describes services, functions, salaries, and training schools for a variety of biological occupations.

*Description of Professions Series, Pamphlet No. 1—Agricultural and Biological Sciences—Employment Service, U. S. Department of Labor.* This pamphlet gives details on fifteen biological professions (and related semi-professions) ranging from Agronomist to Zoologist. Major branches of each are described. Functional specializations are given. Professional affiliations and civil service ratings are indicated. Educational qualifications are set forth and sources of employment are listed.

*Occupational Outlook Handbook*—Supt. of Documents, Government Printing Office, Washington 25, D.C. This is a comprehensive handbook reporting on 288 occupations including major types of farming.

*Outlook for Women in Biological Sciences—Bulletin No. 233-3*—U.S. Dept. of Labor, Women's Bureau. This pamphlet deals with biological occupations especially open to women.

*Education for Forestry*—State University of New York, College of Forestry, Syracuse, N. Y. This is an excellent university pamphlet giving a full description of the education of a forester.

*Getting Started in Poultry Farming*—Bulletin 679—Cornell University Extension, Ithaca, N. Y. Gives a good description of the practical and business aspects of poultry farming.

*Your Opportunities in Science*—National Association of Manufacturers. This is an outstanding example of some of the superb material produced by industry. Significantly, it is one of the very few publications that includes the career of teacher. It also includes the career of patent attorney, the technical librarian, technical writer and technical salesman.

*"There are scores of young trained naturalists, geared to the thinking of the Mid- Twentieth Century, who will achieve in their own way worthwhile things comparable to the attainments of the great naturalist-teachers of a century ago."*
*—Vinal.*

# Outdoor Education *is a* Profession

*By* WILLIAM G. (Cap'n. Bill) VINAL
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FIFTY YEARS ago, college biology was mass-controlled. Lectures were dictated, to be regurgitated in periodic examinations; laboratory periods consisted of peering through compound microscopes and making mechanized drawings of what one was *supposed* to see. The timekeepers declared that two hours of "lab" were equal to one hour of note-taking. Biological education consisted of pouring facts into cement forms to jell into hunks of concrete thought. Biology courses of today have often inherited this pattern of totalitarianism.

The writer was probably the "last of the species" at Brown University to concentrate in biology with zoology as a major and botany as a minor. All others specialized in such restricted fields as bacteriology, chemical physiology, comparative anatomy, or plant pathology. After the days of Alpheus S. Packard, who became "Professor of Zoology and Geology" (1878), specialization became narrower and narrower. The old-time naturalist went out with the passenger pigeon.

In the meantime, educators discovered that mental disciplines cannot be transferred; education is more effective when functional. (For example, few will dissect earthworms or use the compound miscroscope in adult life.) The group process is democracy in action. Against this the biologist put up his academic umbrella. Anyone who had traffic with "unwashed" education was a "rebel." For this reason, my own straying from the flock of purist-biologists will have to be personalized.

My innate interest in *all nature* is due to many factors. My initial good fortune was the selection of parents who lived and enjoyed the simple rural life. For eighteen years I was a farmer boy with all the freedoms and joys it implies. Early association with such personalities as Arthur Clark Boyden, Anna Botsford Comstock and Edward Howe Forbush showed me the dignity of being a naturalist-educator. I could hold my head up and do Boy Scout work. I further discovered that every time I did service in an area related to natural history that I was the one who intimately gained. Ranger naturalist work in the National parks *(Nature Guiding,* 1926, Comstock Publishing Company) eliminated the "sacred cow" of memorizing; two years with the National Recreation Association *(Nature Recreation,* 1940, *Mc*-Graw-Hill) was convincing that nature is worthy of enjoyment. Some thirty years of camp leadership; plus a summer spent in surveying European Youth Hostels, substantiated as well as broadened my outlook. There was

no returning to the ivory tower of a closet naturalist. The objection of course, is not to biology as a *subject,* but to the *method* of its study.

The union of natural history and pedagogy dates back to Europe. Rousseau (1712-1778) who carried out the idea of Comenius (1592-1670), Pestalozzi, his student Froebel, and his countryman Louis Agassiz had great influence on nature-study in America. Master nature teachers such as Agassiz, Guyot, and Asa Gray at Harvard. Liberty Hyde Bailey at Cornell; Colonel Francis W. Parker and Wilbur S. Jackman in Chicago; and William T. Harris of St. Louis caught the spirit —not from tradition, textbooks, lab work, or written reports, but by contagion. They spread the gospel of simplicity, reality, and personal experience to be gained by contact with living nature. They represented the initial centers of development of nature in the United States. The pioneer period of naturalist-educators and their disciples in American nature-study, therefore, was from 1850 to 1910.

### *The Black-eye Period*

The early part of the twentieth century was unfortunately a *black-eye* period for nature-study. About the time that the writer entered the scene at the Rhode Island Normal School (1910), nature-study was in bad repute. It might be described as in the fluffy-duffle stage, as teacher skipped across the fields with butterfly nets in the spring—tra-la! Their biological knowledge was practically zero. The writer made a study of thirty-three first grade readers (Nature Study Review, Dec. 1918, pp. 371-379), and found that although half the stories were about animals, over two-thirds of these animal stories were either fables, or had the animals act and talk as human beings. Out of thirty-eight cat stories, for example, the ten that could be classified as approaching respectful cat yarns were on the level of the kitten-mitten episode, the pussy cat and the queen, and a kitten baking pie. Nature study was set back several decades by this "froth" method.

Perhaps, equally vicious, were the teachers who thought that nature-study meant *fact-stuffing.* So many of them became obsessed with the brain-trust idea that the very mention of nature study in camp would be met by a chorus of groans. A few camps resorted to the scheme of employing nature counselors under the disguise of "pioneer leaders." This subterfuge called for a definite brand of leadership. Do not think that the phonograph record gave way to adventurous experiences without a long struggle!

Each act of rebellion called for *new terms. Object teaching* i.e., emancipation from the textbook, was introduced at Oswego Normal by Dr. Edward A. Sheldon in 1859. In 1878 Professor H. H. Straight, who studied under Agassiz at Harvard, and Professor Penikese started *nature-study* at Oswego. In place of the laboratory-schoolroom lesson he took his classes on field trips to study living plants and animals. Enos Mills originated the idea of *nature-guiding* in about 1888. For nearly twenty years he conducted parties up Long's Peak in Colorado. In 1920, Dr. Harold C. Bryant commenced the outdoor *interpretive service* of the National Parks in Yosemite. In the same year a *nature-lore* school was organized on Cape Cod to train nature counselors for camps. Not only camping but the Audubon movement,

4-H clubs, conservation, school forestry, and sporting clubs are varying forms of abandonment of ritualistic biology. Since public school camping and nature recreation are segments of a greater movement, it appears appropriate to adopt the all-inclusive term *Outdoor Education* to distinguish this new profession from traditional Biology.

### *The Renaissance Period*

It is obvious that the renaissance of nature study in the form of the profession of *Outdoor Education* has been very gradual. It has crept upon us, so to speak, in so many forms that assembly line biologists do not know that it is here. The purpose of this article is to announce that outdoor education is not only here with respectability, but that it is a lusty youngster. The writer might also add that he did not dare present the facts without a resumé of the major pitfalls and struggles, even battles, that took place in achieving the results.

The crop of budding generalists must not get the idea that this profession requires less training than other areas of biological endeavor. The outdoor educator has to know his stuff in biology or be a vulnerable target. He must also be a competent field man—which is unusual in biological training. Added to this he must be a practicing educator not a mere theorist. Furthermore he needs to be a humanist, writer, conservationist, psychologist, recreationist, camper, and expert in handling both adults and children in the field. This is a large order, but the fact remains that an outdoor leader is no stronger than the weakest link in the chain of preparations listed above.

### *Fundamentals of Preparation*

*What courses do recreational-naturalists select?* These figures given below are for University of Massachusetts Junior-Senior biology majors in the academic year 1950-1951. Students, instead of being restricted were given complete freedom in selecting courses beyond the biological field courses in which they were concentrating. In this specific year, 87 allied courses were chosen. The 21 naturalists enrolled in *physical-education* courses proved camping to be the most popular. Courses in *education* registered 9 naturalists. Audio-visual aids was the leading course. *Music* courses had 7 representatives. It would evidently be folly for some biologists to invest in music, yet those naturalists who could lead singing or play an instrument were better equipped for leadership. Courses in *zoology* and in *entomology* had 6 nature recreationists. All 26 naturalists elected entomology, which was very popular. *Botany* had 5, ecology being the favorite. *Geology* and *modern languages* had 4. Health, government, English, and philosophy each had 3 naturalists. In English, many naturalists recognized the importance of training in creative writing and in public speaking. Electing Dramatics, as in many courses, was also determined by popularity. There were two in each of the following fields: Agriculture, Floriculture, Forestry, Home Economics, Psychology, and Veterinary Science.

It is evident that every student naturalist could not elect every course. Their complaint was that there were so many attractive offerings. Although this record shows what students in general natural history (1951) se-

lect it should not necessarily be accepted as a criterion for a course of study. The important thing is that it portrays the freedom of the individual as against the ball-and-chain curriculum. Tailoring courses to individual needs, interests, and capabilities is essential for success. Naturalist-educators today, as in the period of the "masters," are self-made and not trained seals.

### *Job Placement*

*In what categories do majors in nature recreation find a living?* The record is for fifteen years.

*Thirty per cent become housewives.* This is not a total professional loss—marriage does not "end all!" Take the chain of events for one young lady: she majored in biology in college; was field director for Girl Scouts two years; spent one summer at Marine Biological Laboratory at Woods Hole; another summer with Clifton Johnson's sea voyage; next lead a Rolling Youth Hostel trip coast-to-coast; spent one summer at *Life's* Girl Camp; wrote 160-page master's thesis entitled "A Study of Some Natural Resources of the Region of Plymouth, Massachusetts, for Use in a Girl Scout Program;" served one summer as Chief Naturalist on Massachusetts' Mobile Unit for Senior Scouts; was a Director of Girl Scouts; became wife and help-mate of a College professor of outdoor education; is raising each progeny as a whole child rather than a set of cubicles for a pouring-in process.

*Fifteen per cent go into social services.* This involves becoming a scout camp director a scout naturalist, or sponsor for outing clubs of Y.M.C.A. and Y.W.C.A. organizations. Some have guided nature clubs at a Settlement House while occupied elsewhere. Many sociology majors took nature education as a cultural course.

*Fourteen per cent study for advanced degrees.* Many graduates, usually men, have found it necessary to get a doctor's degree in ecology which might be defined as advanced nature education. Almost without exception these students are teaching fellows. Their letters and opinions are interesting: "I conducted a wee experiment to see how many freshmen could identify maple flowers. Not a soul had an idea. I'll try dandelion next. Caught a couple of snakes and found that all the grad students in zoology would sooner die than touch them." A graduate at Rutger's has a favorable comment: "I am at present taking a course in Bioecology. There are three professors,—a botany-ecologist, an algologist, and a zoologist. It would do your heart good to see the out-of-doors being studied as a unit and not as individual subjects. My problem and thesis is "The Ecology and Vegetation of the Watchung Reservation." There is to be a section containing a suggested master plan for recreational development."

Professional jealousies in some universities prevent botanists from taking any zoology courses or mingling with entomologists. That is not the case at Rutger's, or Oregon State College where a Ph.D. candidate in Biological Field Studies writes enthusiastically about the inter-departmental cordiality. Most of the student obtaining a doctor's degree expect to teach general natural history on the college level. Dr. William Randall, who has just completed his doctorate at the University of Wisconsin, is inaugurat-

ing a new department of nature recreation at the University of Illinois (September 1952). He really heads a "laboratory of outdoor living." Professor Reynold Carlson at the University of Indiana has a similar department.

*Ten per cent teach nature or science in the elementary grades or in High School.* Public school camping is most attractive work for naturalists. Leslie Clark, formerly director of Battle Creek Public School Camp, has just been appointed to head the Boston University Sargent College Camp and to devote a part of his time at the University. There are three phases to his work: a children's camp; junior counselor training in outdoor education; and teacher training in outdoor education. The Ontario Department of Public Instruction conducts a camp counselor training course and reimburses the cost. The 250th school report (1951) for Newton, Massachusetts, highlights public school camping. All candidates for teaching are expected to have proficiency in this area.

*Seven per cent are classified as naturalists.* Perhaps this grouping should be united with the teacher group. Itinerant Aubudon workers, for example, go from school to school teaching nature and conservation. Staff naturalists in children's museums usually meet children at the museum or in the field. Humane education workers are devoted to the animal side of nature. To be successful, all of these must possess teaching techniques. School gardens in many places have declined for want of trained enthusiastic leaders.

*Seven per cent go into recreation.* Although in demand, it would be exceptional for a trained naturalist to go to a city playground. He would be like a "hen" with a brood of ducklings. Several "grads" have become playground administrators with appreciation for nature as a major recreation.

*Six per cent venture into nature therapy in hospitals.* Although students enter this work with enthusiasm, and are in great demand, they rarely remain more than two years. This is particularly true in hospitals for the mentally ill. Yet the pay and retirement is exceptionally good in Veteran Hospitals. Most hospitals have green houses but they are "verboten" for "guests" (patients).

*Five per cent are "lost" to our records.* It is likely that they are in occupations unrelated to nature and, hence fail to keep contact with their former associates.

*Three per cent enter religious work.* It may surprise biologists that there are openings for naturalists in church activities. Church camps have increased at a phenomenal rate. Along with this has gone a recognition of the value of nature's handiwork.

*Three per cent are deceased,* the majority being war casualties.

### *Conclusion*

This paper has been a resumé of the decline of *nature study* followed by the renaissance of the movement under the heading of *Outdoor Education.* Space does not allow an elaboration on the techniques of training of these new leaders. Great hope is based on the fourteen per cent headed toward advanced degrees. World conditions have interfered with some careers. One graduate has just left to be transportation officer in Japan. Another is government inspector of meat, dairy

products, and eggs in Baltimore. Their GI Bill of Rights and innate determination to become "generalists in the outdoors," plus their unsolicited war experiences, will make them better leaders. A recent Doctor of Philosophy from the University of Maryland is doing hush-hush research work for Uncle Sam.

Readers must not underestimate the contribution of the thirty per cent who become housewives, for certain of their biographies are as exciting as the "most unforgettable characters" appearing in *Reader's Digest*. Take G. T. T., for example: Raised on a poultry farm, first year after graduation a naturalist in the Indianapolis Children's Museum; second year youth work with Friends Service; third year married in a Friend's Church and hosteling in Europe to think out their niche in life; now directing Good Will Homes and Schools in the rural setting of Hinckley, Maine. Or listen to the career of P. S. H.: A winter in a lumber camp, ridin' the range; Ranger Naturalist at Mt. Tom State Reservation; Red Cross Recreation Worker in European theatre; Director of American hostel trips in Europe; married, studying anthropology with husband in Denmark; summer 1952 living on Indian Reservation, with two papooses of her own; now back at Cornell University where her husband is candidate for a doctorate in Cultural Anthropology Knowing this couple and their natural history background, I am certain that all the biological laws known about humans and other animals will be at the base of their accomplishments.

In Outdoor Education there are today more positions than leaders. A children's museum on the south Atlantic seaboard will have to wait until qualified specialists have finished their year's contract. There is no one at present who calibrates with the request for a creative nature writer to become editor of a state wildlife magazine. A mid-west college is seeking the rare-to-find qualified "field scientist" who will develop a unified core curriculum in its 1000-acre endowed ($500,000) widlife sanctuary and public school forest. The candidate, at a beginning salary of $5500, must be qualified to train college students, public school children, and citizens of the community. The college is unwilling to accept the product of a moth-eaten, obsolete school of rigid, biological ideas.

The writer believes that there are scores of young, trained naturalists, geared to the thinking of the Mid-Twentieth Century, who will achieve in their own way worthwhile things comparable to the attainments of the great naturalist-teachers of a century ago. The writer has a firm conviction that these devoted crusaders have found a true vocation based upon science. They will fully earn their livelihoods. More than that, they will battle for their belief in the outdoor life-adjustment program. The writer, furthermore, has as much faith in the Outdoor Education profession as he has in democracy and the goals of the United Nations. The objectives of these movements must and will succeed even if under a new name. It will mean long, unstinted, uphill work. God bless America!

*"An experiment differs from a blind trial in that it arises from a logical design, in which some opinion concerning the way things are is tested systematically. Children can learn to do this."—Foshay.*

# Foundations *for* Guidance Toward Science

*By* ARTHUR W. FOSHAY

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SCIENCE is organized wonder. Our wonder about the significance of natural phenomena is organized through the methods and institutions of Science. People are naturally curious, but they are not naturally scientific. The step from the one to the other must be learned, and it is toward this learning that training in Science is directed. The teacher's task is to help the child give form to his wonder; to help him organize his curiosity so that it may lead to generalizations of value to him. In guiding children toward scientific occupations, therefore our basic task is that of channeling wonder into organized activity without destroying it. The concern of teachers with this matter is heightened by the great need of our times for more imaginative scientists.

In this paper two aspects of the educational problem will be considered: First, the relationship between scientific inquiry and personal emotional security. Second, some implications of this relationship for guidance workers.

I. *The relationship between scientific inquiry and personal emotional security.* The fact that the ability to engage in scientific inquiry is related to a person's feeling of security is quite generally overlooked. The whole emphasis of our science curricula, whether in the elementary school or in the graduate school of the university, is "objective" in the sense that it purports to deal with the tangible—birds, heat, chemicals. Very seldom indeed do people question the assumption that "objective" means "impersonal." One doesn't think of a man who devotes his life to the development of new plastics as primarily engaged in interpersonal activity. Yet if he explains candidly, his reason for doing a certain piece of work, the chances are that his real motivation will appear—to do something that will enhance his reputation with other chemists. The plastics are instrumental. If one has ever attended a meeting of scientists, it is clear that even the most eminent among them venture out into the unknown chiefly in terms of what they think will be acceptable to their peers.

Children, even more than chemists, rely on one another and the teacher for direction of their inquiry. Only in the degree that they are personally secure will children venture out beyond the book. Original inquiry among children arises from solid emotional foundations. Imaginative children are happy secure children. Insecure children can't take chances. Their world

must be structured for them. Insecure people don't work well with others; they don't trust their own ideas. A fearful child is not curious; he is preoccupied with his own fear and has little intellectual energy left to devote to the advancement of his own knowledge about anything except his fear. A child lives a life largely devoted to maintaining a balance among the various forces that affect him. If these forces (parental attitude, status with peers, status with teachers, and so on) seem to the child to be out of balance, he is compelled to devote all of his energy to their realignment.

Our task in the schools is two-fold: To help children toward a personal security that will permit them to be original, and to help them give form to their original inquiry. To do this we must find levels of scientific inquiry appropriate to the stage of development of the children we are dealing with.

When one thinks of guidance toward scientific occupations, personal security becomes especially important. Again and again, those who employ scientists point out that the people they need most are those who are willing to go beyond the book. The scientist is of only routine value if he can do only routine work. The scientists who are of great value to the country are those for whom a formula is only an instrument, not a finality. We need formulators, not followers of formulas. If we are to locate real potential scientists in the high schools, then, we need first to find people who are sufficiently secure to be bold, and only secondarily to find those who have the particular aptitudes for scientific activity that can be tested through the established instruments. In the high school this means that guidance workers must find people who are bold enough to ask unconventional scientific questions, and help others to develop the personal security that permits this kind of boldness.

II. *Some implications of the scientific inquiry-emotional security relationship for guidance workers.* Our needs here outrun our knowledge. Nevertheless, we must act, even on incomplete knowledge. What has been said above implies certain things guidance workers should do. We shall discuss three of them here.

Guidance workers need, more than a knowledge of the tests and the rules for giving tests that will find scientists, an ability to infer from children's questions the types of interest and readiness they now have. Children show both their security and their readiness for study through their questions, their aspirations, their hobbies, and so on. It does not often occur to a teacher of chemistry that a look at the free art work of a child will indicate to him the degree to which the child requires a highly structured environment for personal peace. Yet this is true, as any sensitive kindergarten teacher can tell you. By the same token that guidance is more than testing, so is teaching more than the organization of information.

Future guidance workers, from this point of view, must add to their preservice experience, extensive practice in the location of the relationship within children of interests and security. Mere mathematical ability does not of itself lead to scientific ability. Unusually developed mathematical ability too often represents merely a search for security in highly structured abstractions. It is not enough to know whether a child has mathematical ability; we have to know why he has it.

Furthermore, guidance workers must be trained to work with teachers in such a way as to communicate this point of view without threatening the teacher's own security. A high school teacher who has spent a number of years developing a particular way of teaching biology will not easily throw out all that he has developed to meet the half-understood suggestions of a guidance worker. The guidance worker is, among other things, an in-service worker—a consultant. This latter ability must be developed on a pre-service basis, if we are to have a training program for guidance workers that will actually lead (among other things) to the development of future scientists.

If children are to be scientific, they must learn to experiment. An experiment differs from a blind trial in that it arises from a logical design, in which some opinion concerning the way things are is tested systematically. Children can learn to do this. The great weakness of science teaching is that we teach children only to validate what is in the book, not to experiment.

But the logic of experimentation must be taught and practiced at great length. Guidance workers commonly are trained to use a logic of experimentation in their clinical work. They, more than others, develop experimental designs to meet old problems which appear in ever-changing guises. Children who are free to ask their own questions will also project the old problems in new guises. Guidance workers can help science teachers to foster the spirit of inquiry. They need practice in helping teachers and children to apply logic to their classroom experimentation with the physical environment.

We have here, then, three practical implications for guidance workers, of the relationship of personal security and scientific inquiry. Further study of this relationship can keep us together as we continue our common quest for certainty.

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*"Fundamentally, we are more heavily committed to a free society than we are to a technically advanced society."—Hobbs.*

# Some Notes *on* Science *and* Guidance

*By* NICHOLAS HOBBS

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THE EQUATION for a human choice is a complex one. In the major decisions of life—such as choosing a vocation—many variables are involved. These variables are the product of the individual's past experience, of his projected future, and of the current situation as seen at the moment of decision making. These many variables all have different weights in the equation, and, to make the problem even more complicated, the weights change with time and with each other.

If we could write the equation for a difficult choice, which of course we can't, it is doubtful that it could be solved by even that master "electronic brain," ENIAC. Such problems are solved, however, by the human brain time after time in an individual's life. Broadly conceived, guidance is a process of helping the individual identify the variables that are relevant to his problem, and to arrive at the best weights for each of these variables in the equation of choice.

Though human choices are complicated, we have a penchant for making them appear simple. Above all, we want our choices to appear rational. After struggling with a decision for many months, during which time hundreds of factors, both obvious and subtle, operate in the shaping of the final commitment, we make the choice, and having made it we look back on our action and pick out several reasons that will appear most logical to an enquirer who wants to know why we chose as we did. We then give him our *post hoc* reasons, usually three of them, since to give only two would make us appear either lazy or brash and to give more than three would make us appear either compulsive or distrustful of our decision. Thus guidance is concerned not only with such obvious variables as aptitudes, interests, and job opportunities but also with myriad subtle inclinations, likes and dislikes, apprehensions, and aspirations.

In a sense, good guidance is not *guidance* at all. It is something different. It is a procedure for supplying needed information to an individual. It is also a procedure for supplying the individual with a climate favorable to decision making, in which he feels free to examine himself, to ferret out his strengths and weaknesses, to assess what facts are available, find verbal labels for inchoate feelings, and to arrive at decisions that are his own. The point of departure for guidance, then, is the individual's own private world. The individual must be his own steersman, and he who would offer "guidance" must not attempt to guide at all.

But guidance is an honorific word.

People believe in it. It is a Good Thing. Consequently, one finds the term popping up in unexpected places, to serve purposes not at all in harmony with the intent of the term. For instance, one occasionally hears such expressions as "guidance into science," or "guidance into the ministry." Now science and the ministry are certainly worthy activities for people to go into, but only when the motivation for so doing grows from the needs and aspirations of the individual rather than from the ambitions of a profession. Promotion of a profession is a legitimate activity, but it should not be labelled guidance.

There is today in the sciences a crippling shortage of trained people. We are beginning to reach the point in our technical society where limits to further expansion will be imposed not by ideas or material resources but by lack of trained personnel to carry out new projects and keep established projects in operation. Our human resources are as limited as our "natural" resources. There is only so much intelligence in our country, as there is only so much coal and oil. We are not yet making use of all of our human resources, as evidenced by the fact that twenty percent of the people who never finish college are as intelligent as those who complete college with creditable records. A major problem of our society is how to ensure the fullest development of the human talent that comes with each new generation. The need becomes ever more urgent. For instance, to build a B-17, the bomber of the last war, took 350,000 engineer man-hours; to build a B-36, a current model bomber, takes 3,500,000 engineer man-hours. And of course this story of increased demand for trained personnel can be duplicated in all the technical fields. Clearly we must find ways of identifying, at an early age, children who have basic abilities necessary for achievement in the sciences and related technical fields, and to make available to them, without regard to their socio-economic status or their race or religion, opportunities to obtain education comensurate with their ability to profit from it.

This is not the whole picture. Extrapolating on present trends, it is conceivable that our society will reach the point where science and technology could employ every citizen who has sufficient intelligence to obtain training to work in one of the technical fields. But a society needs more than scientists. If it is going to be a society worth living in, it must have its philosophers, poets novelists, musicians, artists, and teachers of children to name only a few of the occupations that are vital to our well-being and that are rightful claimants to the talent in each generation. For a while it appeared that the atomic scientists were going to double in brass and serve as social philosophers, helping us clarify our common objectives and understand the awesome instrument available for productive endeavor as well as for the annihilation of others and ourselves. But apparently they became discouraged by the burdens of social leadership and turned to find sanctuary in their laboratories.

From the standpoint of the needs of our society, we must hope that a balance will be struck in the utilization of intelligence and talent, that our creative energies be invested not alone in technical pursuits, but also in philisophical endeavor, by which values are established, and in artistic endeavor,

through which the spirit of a people is enriched.

A basic value, rooted deeply in the traditions of our society, is the concept of individual freedom and responsibility. Fundamentally, we are more heavily committed to a free society than we are to a technically advanced society. There is evidence in plenty that technical achievements are possible even in societies that have little concern for the individual. Conceivably, we might increase considerably our reservoir of scientific talent by rigging our educational system to channel most of the bright students in the direction of scientific and technical studies, and by promotional campaigns directed toward getting every person with scientific aptitude in the sciences. On the surface, this might appear desirable, particularly to people who are themselves interested in the development of science. But underneath, this would be a hollow achievement. To preserve the basic values of our society, we must keep the individual central, and, except in times of emergency, have the needs of society served as individuals are themselves prompted to serve. We must have room in our system for the person with high promise in science who decides he wants to be a concert pianist, and for the person with great leadership potential who prefers to work alone in a laboratory.

We cannot have guidance that is committed ahead of time to particular directions for individuals. Directions must spring from within, and each individual must find his own best directions. People interested in providing guidance can do two things: they can make sure that the young person has an opportunity to know his capabilities and to become familiar with the various life pursuits in which he may find satisfaction, and they can provide for him an opportunity to talk with an understanding person who believes in the capacity of the individual to make good choices. With such provisions, the young person is likely to find the right variables, the right weights, and the best solution for his own personal equation of choice.

*"The science supervisor should act as a liaison between community, industry, and the science teacher."—MacLean.*

# Supervision *of* Guidance Toward Science

*By* ARCHIE J. MacLEAN

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GUIDANCE, what is it? We hear a great deal about the importance of guidance in helping students to plan for their future, not only vocationally but also as to the kind of a person they wish to be. Courses and units of work on orientation given at various grade levels and in various subject fields tend to emphasize guidance as one of their major objectives. Guidance by the science teacher will involve both personal and vocational guidance for the pupils in his classes.

Today in many secondary and even in some elementary schools there are specially trained counselors who are prepared to administer various tests of ability and aptitude. The results of these tests help pupils to know more about themselves, and aid them in making plans for the future. However, much of the personal and vocational guidance must be done by the classroom teacher. It is in this capacity that the science teacher has an excellent opportunity to seek out and to encourage pupils to take up some phase of science as a career.

Assuming that the science teacher should carry on personal and vocational guidance in science classes, what is the service of the science supervisor? The supervisor should be aware of the important function of the science teacher in the guidance of the pupil, and should provide assistance for the teacher in carrying out this rôle.

Some ways in which the science supervisor can help are these. Encourage the teacher to make definite plans for carrying on personal and vocational guidance. The teacher should learn as much as possible about the pupils in his classes. This can be done in many ways, such as using a simple questionnaire containing questions that will give the teacher information about the interests and family of the pupil, requesting an autobiography, talking with pupils, or listening to their conversation with each other. The teacher may wish to use the sociogram to add to his knowledge about pupils. Certainly the teacher will consult pupil records for information about mental ability, health conditions, reading ability, and other pertinent information. With as much information about the pupil as possible the teacher will then be in a position to discuss future vocational plans with him, also problems of health, and personal problems.

The science supervisor will not only encourage the teacher but will provide opportunities for the teacher to learn more about ways of counseling and ob-

taining up-to-date vocational ideas. Literature for the teacher's information should be provided. The alarm concerning the shortage of technical workers has produced a number of articles that describe scientific careers. Workshops for the discussion of techniques in guidance will be of invaluable assistance.

The supervisor can arrange for meetings where information is given, and discussions are carried on that will offer the science teacher help in carrying on guidance activities. Inquiries may be specific, as how do you plan to use the vocational informations that you have collected? Do you set aside a certain time to discuss with pupils vocations in the field of science, or is such information given incidentally as questions are asked? Do you make it a definite part of your teaching plan by giving guidance a place where it fits to advantage? How do you use speakers from the community? The engineering groups are very active in providing information and speakers to encourage pupils to take up fields of engineering. Certain films can be used to advantage in pointing up types of work carried on in various science fields, such as some of the films showing the work of the forest ranger, the oil refinery, or others where various types of scientific work are illustrated. Do you use these films?

The science supervisor should be alert for opportunities to call attention to the vocational offerings in the field of science to school administrators and school counselors. Not only should the supervisors stress the importance of interesting pupils in the vocational fields of science, but also work to promote interest in science teaching as a career. To carry the load of training pupils for careers in science we must have sufficient well trained science teachers. This is becoming an increasingly serious problem.

Science supervisors can supply teachers with some of the newer vocational materials to use with their classes, such as, "Your Opportunities in Science" distributed by the National Association of Manufacturers, and "Can I be an Engineer" distributed by the Department of Public Relations of General Motors. The U. S. Department of Labor also has a series of pamphlets on the vocations in science.

Visitations for interested pupils and their teachers to universities and industrial plants are other ways in which the supervisor can encourage interest in science careers. The science supervisor should not overlook any opportunity to encourage industry to provide scholarships for pupils interested in a science career.

All of these ways in which the supervisor helps teachers plan for greater emphasis on guidance in the science classroom point to one thing—the science supervisor should take the lead in pointing out the need for guidance, and providing the sources and background information for the teacher, and act as a laiason between community, industry, and the science teacher to the end that the scientific age in which we live may have well adjusted citizens and sufficient technicians to maintain leadership in the atomic age.

*"The science teacher should never forget that the most effective guidance is personal"—Johnson.*

# *A* High School Teacher's Opportunities *for* Guidance Toward Science

By PHILIP G. JOHNSON

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THE TYPICAL high school science teacher is responsible for five classes. Each class may enroll anywhere from fifteen to forty boys and girls. Here we have from 75 to 200 living opportunities for guidance. In the required science courses about one-half of this number will have intellectual ability that is equal to or above an IQ of 100. In the elective science courses the median intellectual ability will commonly be well above the normal for all high school youth. Thus it seems reasonable to assume that there are in your science classes large numbers of students who by proper guidance may find satisfying and useful careers in scientific and related work. What can a teacher do to face up to these opportunities?

### *Guidance Activities Within the Classroom*

Little or no attention will be given here to the formal guidance activities which classroom teachers are often called upon to provide. Of course, science teachers do become part-time or even full-time guidance counselors. They also become members of committees on the program of studies, and they may serve as vice principals where considerable attention is given to guidance. But what can they do as classroom teachers?

1. They can encourage students to explore career opportunities in relation to each topic that is stiudied.

2. They can keep an open file of career information and expect students to consult this file from time to time. In the last year there have been produced many new items of career information.

3. They can display career information pamphlets, articles, and pictures on the tackboard, and they can show career-centered films.

4. They can assign or otherwise encourage students to read books and articles that reveal the work of scientists, engineers, technicians, and related craftsmen.

5. They can encourage pupils to undertake projects which will cause the students to work like young scientists in activities that are preludes to research.

6. They can invite scientists and engineers, often alumni of the school, to meet with the classes and talk about opportunities and the preparation required.

7. A few students can be selected and given special help so that they can serve as laboratory assistants. Such help can be provided outside the teaching schedule or as a part of a distinct course in laboratory techniques.

### *Guidance Activities Within the School*

When scientists, engineers, and technicians are invited to help with guidance activities, it is often appropriate to provide an audience larger than a single class. Plans can be made to involve the whole school. What types of services could be arranged to provide guidance for all pupils as well as to the faculty in a school?

1. One or more science clubs can be organized, and a club program can be developed to provide special activities for students with science interests.

2. It would be possible for the science teacher to work with students in planning and presenting a dramatic skit as an assembly program. The theme might be "Mr. Scientist and His Friends" or "Scientists of Yesterday and Today."

3. A scientist, an engineer, and a technician could be invited by the science teacher to speak at an assembly. They could discuss their work, opportunities in the next few years, and how to get ready for them.

4. The science teacher could work with the students and the school in carrying through a science fair either as a separate activity or as a part of an all-school fair or open house. Using scientists, engineers, technicians, and craftsmen as judges help all youth to receive guidance both directly and indirectly.

5. The science teacher could work with the guidance personnel in planning and carrying out an occupational interest survey. Getting all students to consider future work is of itself a help in guidance, and it causes many students to seek further information about occupations and careers.

6. The science teacher could assist the guidance personnel in planning and carrying through a career conference. In this activity pupils and parents would have an opportunity to discuss occupations and careers with several persons actually at work in these occupations and careers.

7. The science teacher could work with guidance personnel in planning and carrying through a "Choose-Your-College Conference." In this activity pupils and parents would have an opportunity to discuss college opportunities with several representatives sent by colleges to counsel with students and parents.

8. The science teacher could assist students in preparing reviews of various occupations and careers for publication in the school paper.

9. One or more advanced science courses can be arranged where attention can be given to special laboratory techniques that can aid the teachers while providing useful training toward careers for the students.

### *Guidance Activities in the Community*

While several of the guidance opportunities previously suggested reach out into the community, there are others that are distinctly community centered. Here are some of them.

1. The science teachers in the various schools, both elementary and secondary, can work together and carry through a community science fair. Individual school fairs can be used to select those suitable for the community science fair.

2. The science teachers can develop—with the help of local scientists, engineers, technicians, and other practicing scientists—a junior scientist's

assembly in which students from all the schools can see and hear demonstrations, talks, and films related to scientific and engineering careers.

3. The science teachers can make arrangements for students to visit various community establishments where work related to science is in progress. The possibilities include hospitals, factories, architectural offices, dental and optical laboratories, radio, and TV shops and numerous service and repair establishments.

4. Reports of the work of student scientists and of practicing scientists and engineers can be prepared for use in local newspapers, radio stations, and as television presentations.

5. The science teacher can arrange for one or more of the large industrial corporations to bring their road show to their school and community.

6. The science teacher can arrange for selected students to attend community meetings of doctors, technicians, engineers, and craftsmen.

*Expanded Opportunities for Guidance*

It is rather common for community colleges and State universities to sponsor such events as open house, engineer's night, lectures, and demonstrations closely related to scientific careers and occupations. Often these institutions will co-sponsor regional or State science fairs and congresses. There is also a National science fair, a National Achievement Awards program, State and National talent searches, and other events. The science teacher can become a means of bringing these opportunities to students in the community.

*The Science Teacher*

It all boils down to the science teacher as the most important person in bringing science guidance services to the students in the school. While many of the services can be so organized that they will reach all students, yet the science teacher should never forget that the most effective guidance is personal. It may involve a friendly talk with a student about careers that appear suited to his abilities. I vividly recall one of my own science teachers who invited me and a few other students to dinner with him, and in the course of the dinner he told us about the careers which he thought we should consider.

One of the greatest rewards coming to the teacher is to visit with former students who were helped to successful and fruitful careers and occupations. Participation in guidance work requires time and thought, but it is worth all of it both to the students, the teacher, and the community. Selfishly considered, the science teacher may be offered a position in a larger school, at better pay, because it is known that he is effective in science guidance.

*"One queer new unit may be offered [in the high schools of 1963]—how to succeed in that strange arena which is college-freshman science."—Read.*

# Science Careers *of* 1963

*By* JOHN G. READ

*College of Education, Boston University, Boston, Mass.*

IT SEEMS now that there will be a shortage of well-prepared workers in science occupations for fully ten years. There will be shortage of trained science teachers in the high schools and the junior colleges for at least six years. This means abundant opportunity for employment. For both groups, financial returns will be those of the upper one-third of the population. Yet the kind of science now taught in most high schools will do little to challenge young men and women who have ability in science. Moreover, the science now being taught will do little for the non-science-minded citizens, who should feel confidence in and respect for the type of leadership in science which we need to run this new world that science has created.

What kind of science therefore, should we teach by 1963?

This "new science" might well ignore certain so-called pressures which many teachers claim hamper their attempts to teach a new kind of science. The fast-fading fiats of college-entrance examinations; the text which tries to teach *all* of a discipline instead of eliminating the outmoded; even the bugaboos of community intolerance or conservatism; these are too often the refuge of a teacher who does not want to change. Real foes of new methods are lack of money for equipment, and lack of time for preparation of demonstrations. It would be far more profitable for science teachers to work for better conditions in these areas than to bemoan the lack of enthusiasm for good science teaching.

Granted, then, a modicum of freedom to do what is needful, functional, and challenging to both the potential science worker and to the interested citizen, what would the new program offer? What would the large units or blocks of subject-matter present? Here is one science teacher's estimate, incomplete but suggestive, readily achieved using existing texts, plus much of the free and inexpensive material available from industry and government agencies. Each heading will be followed by suggested topics, then possible job-opportunities *related to that area* will be mentioned. Finally a brief view of how these topics may be presented a decade hence in the three-or five-year program of the secondary school (grades 10 through 14) will be given. The whole program assumes excellent required science in grades seven through nine, and possibly in grades one through nine.

1. *Biology.* Here is the science for all in the high school of 1963. Food-production, forest conservation, soil management, agriculture—all are words which touch on the greatest business in America, working on the land. When added to this there is conservation of human resources, both physical

and mental, nutrition, care of the young, the old, and the ill, (all to be considered as bases for careers,) the sum is *the* most-important area in science education!

What are some specific careers in biology? Research and application in agriculture, embracing insect-control, genetics of new plants and animals, soil chemistry, forest management for the present and the future, medical and health services, production of antibiotics, drugs, and industrial molds and enzymes—these offer thousands of opportunities for careers and service to mankind.

2. *Chemistry.* Chemistry in high school of 1963 should still be closely tied to living processes—should be largely biological. The nitrogen, carbon dioxide, oxygen and water cycles are influenced by artificial—hence chemical—fertilizers and soil-conditioners. A major function of familiar chemicals is the control of insects and harmful micro-organisms. Another "live" aspect of chemistry concerns human anatomy and body fluids—an area of interest to adolescents.

Certain other influences of chemistry loom large in socio-economic discussions—such as the multitudinous products of coal, petroleum, natural gas, and cellulose. The chemistry of these can be presented simply, with emphasis on their usefulness to man, and the fine types of practical research that has developed them. An understanding and appreciation of the rôle of chemistry in the modern man's world is a satisfactory outcome for this type of course.

It maybe, however, that good coverage of atomic structure, and ideas of molecular reaction especially between organic compounds, will stimulate certain students to more than an educated layman's interest. For these, there may be the challenge and the dream of chemists-to-be. Chemistry, like biology, will offer an endless variety of occupations from the highest researches to the skilled technical responsibilities. No let-up in The Chemical Age is in sight.

3. *Physics.* Mathematics is the key to careers in physics. This is not to say that other areas do not need mathematics, but when they do, they are treading the borderline of physics. The career-leaders in this field are the very able scientist-mathematicians, and the development engineers. For each one of these, industry rquires some five men or women with skilled hands and trained ingenuity, to shape the paper-ideas into reality.

High school students of 1963 should be introduced to all aspects of communication—telephone, radio, radar, television, sonar and other developments—and to certain other basic concepts such as nuclear structure, and measurement of forces as varied as the strength of great bridges and the impact of electrons in a vacuum-tube. The few who really pass this rigorous screening should be cherished, and introduced to other topics that will make them exert every ounce of their intellectual force. As career-physicists we may expect these to probe into the stars and time, and to contribute—through their achievements and their heartaches—to the safety of the nation and the prosperity of the world.

And now, how will the high school science program of 1963 appear with such purposes? Every student will finish the three required years of general science in junior high school with a good picture of the physical world.

He will have enough basic concepts to interpret and classify almost any daily happening he is likely to run into. Next he will study biology for one to one and-one-half-years with much indoor and outdoor laboratory experience. The home nurse will help, local doctors will be part of the staff, social agencies will participate. Read "New Directions in Science Teaching"[1] to see what kinds of programs will actually work. Then, after all have had this kind of biology, some will go on to special nurse's preparation; others to adventures in agriculture, with field work (now admirably done by state and Federal agencies). Both young men and women will profit by counsel in care of children, and the adjustments to that career—home-making—which becomes either a part- or full-time job for so many.

Two kinds of elective program will then be offered in high school. A mature presentation of high-level physical science will appeal to many, with chemistry, astronomy, and earth-science interpreted in terms of adult and current reading. Much of this would not be text-book study, but would be reading , reports, trips, and a wide use of idustrial visual aids. For those who have already decided to make science their occupational path, chemistry and physics will be offered, with a prerequisite of simple calculus. Laboratory situations will pose real analytical problems, but no attempt will be made to "cover" the two subjects. One queer new unit may be offered—how to succeed in that strange arena which is college-freshman science!

All the way from grades seven through the junior college, students can participate in the Science Fair[2] also in seminars or junior academies of science. Everyone will not wish to do this, but those who do so will find that they *already* have begun careers in science, and are not merely *preparing* for them.[3]

1 Laton, Anita D. and Samuel Ralph Powers, "New Directions in Science Teaching," McGraw-Hill Book Co., Inc. New York, 1949.

2 For free brochure on Science Fairs, write to Cambosco Scientific Company, 37 Antwerp Street, Brighton, Boston, Mass.

3 Write for:

"Can I Be an Engineer?", Department of Public Relations, General Motors Corp., Detroit 2, Michigan.

"Your Opportunities in Science," National Association of Manufacturers, 14 West 49th St., New York 20, N. Y.

"Target: Science In *Your* Future." Chief, Personnel Branch, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

*"Adolescents seldom undertake such [creative] activities voluntarily; someone must make a suggestion, and then offer frequent encouragement until the undertaking nears completion."—Sipe.*

# Guidance Toward Science Teaching

*By* H. CRAIG SIPE
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A STUDENT said to me the other day, "I would like to become a science teacher. I know that the work is hard and the pay is moderate. Yet I like to work with young people, and I like to study science. Can you give me some advice about the courses I should take?"

A short time later a former student, now teaching, came by to talk over the opportunities for scientists in industry as compared with those for scientists in teaching. Meager facilities had plagued his efforts to carry on desired laboratory work. When he had used field trips in the teaching of science, the critical remarks of his colleagues had disheartened him. His vision of usefulness as a teacher had been dimmed.

Experience with similar instances has demonstrated that the problems of guiding youth toward science teaching may be categorized about (a) the recruitment, (b) the training, and (c) the orientation of science teachers. The failure of the guidance program in any one of the three areas surely will result in an inadequate number of competent teachers sorely needed to perpetuate our technical civilization, and crucially required for interpreting the coming "hydrogen age."

It is assumed here that the choice of a career is a matter of reason as well as inclination. The thoughtful self-examination of one's assets and liabilities is prerequisite to a wise vocational choice. Counselors share with parents, classroom teachers, and others the task of creating an atmosphere favorable to the development of a young person's attitudes, desires, and abilities. Unless a counselor claims omniscience, he must admit that his chief aid to a maturing adolescent is that of helping to clarify the meaning of test scores. the significance of competing desires, and the worth of conflicting experiences. The right to choose a vocation belongs to the individual, for it is he who must muster the energy to prepare for and to practice his profession.

The desire to teach, or for that matter the desire to engage in some other activity, does not appear instantaneously. Rather, the will to pursue a particular career seems to spring from the experiences one has had in the past and is continuing to have in the present. The high school pupil who has found satisfaction in mastering the workings of a clock or the secrets of baking a cake has developed an attitude favorable to scientific inquiry. The thrill that comes with communic-

ating an idea—the rôle of the sun in causing the rainbow, for example—to another is the property of a pupil disposed to share his knowledge. The rewards of creativity are known to the designer of model airplanes. The older boy or girl who has worked with a class in a church school, with the Cub Scouts, or with the Brownies has probably found satisfaction in being of service to others. These are among the attitudes, interests, and abilities commonly possessed by scientists who are also teachers. Adolescents seldom undertake such activities voluntarily; someone must make a suggestion and then offer frequent encouragement until the undertaking nears completion. Thus it is that teachers in the elementary school, parents, youth workers, and teachers in the junior high school play an important part in the guidance of youth toward science teaching.

High school science classes provide rich opportunities for teachers to extend and to capitalize upon the evolving interests of pupils. Many is the time that an impatient hand and active tongue can help perform a demonstration or can explain to a classmate such subjects as the action of an antibiotic or the principle of a jet engine. In simple tasks the pupil has an opportunity to extend his range of talents and to discern his strengths. When the teacher, in informal chats, shares with pupils his insight into the work of a teacher and the joys of teaching, he provides them with facts and attitudes they will weigh in arriving at vocational choices. It is in the high school classroom that those interested in teaching often build a vision which guides their subsequent efforts at making the goal of science teaching become a reality. Other professional groups —engineers, dentists, doctors, clergymen, business managers—covet the opportunity that teachers have to put their case to young people. Would that science teachers use to the full every chance that is theirs to perpetuate their important calling!

Decisions about one's lifework have roots in the early experiences of an individual. The influence of advisors and faculty members on the vocational choices of college students seems to be overestimated. Their function seems, for the most part, to be one of bringing to fruition the seeds of interest and aptitude sown by others. In the case of prospective science teachers, college personnel can and often do help students to decide on concentrating in the physical or biological sciences, or on preparing to teach at the junior high school level, the senior high school level, or the college level. Comparatively few students, it seems, become first interested in science teaching through the efforts of a college faculty. The recruitment of teachers is a cooperative effort enlisting all persons who have influenced and continue to influence the individual student.

The guidance of science teachers in training concerns (a) the selection of courses, and (b) the professional preparation in science and education. Experience has demonstrated that a guidance program for training teachers fails when courses in science and in education are taught in isolation, for the student then relies more on *how* he has been taught, even though this may be a wretched example, than on *what* he has been taught concerning instructional theory. The professionalization of science subject matter has been suggested as a means of overcoming this difficulty. In courses which resemble

the type of material the neophyte teacher may be expected to teach, a scientist-educator may exemplify the best in teaching and may provide opportunities for student work on projects related to science instruction. Such a project could well be that of tape-recording an explanation accompanying a demonstration suitable for a class in the science general education program. Here the constructive criticism of a professor trained both as an educator and a scientist can do much to emphasize the importance of detailed fact, the necessity for a full understanding of principles, and the difficulties one encounters in communicating an idea.

In other instances the creative and resourceful science instructor may suggest activities bearing on the method of science and the contribution of science to our society. The student who enters courses in the philosophy of education, and undertakes the teaching practicum with a background provided by well-designed professionalized science courses, will be more likely to find meaning in the procedures advocated by competent educators. The guidance of the potential science teacher in his program of training may be described as a cooperative undertaking of student and instructor, and of the professional scientist and the professional educator.

Too often overloaded classes, unsatisfactory equipment, and heavy extra-curricular responsibilities leave little time for the beginning science teacher to apply his knowledge of how to teach to his classwork. Unless the sympathetic guidance of one in whom the teacher has confidence becomes available, this individual will probably become discouraged. Indeed, he may decide to leave teaching for other work in the field of science. This very real danger calls for the study of such promising practices as the establishment of "apparatus lending libraries" to serve a region, the institution of special in-service training programs, the use of local conferences on science teaching, and the employment of regional instructional counselors specially qualified in science. The development of a more effective program of guidance for beginning science teachers constitutes a challenge to all who are interested in perpetuating our technology and in interpreting effectively an age of science.

In summary, guidance toward science teaching is a cooperative effort based upon providing a young person with opportunities commensurate with his interests and abilities. Effective guidance extends from childhood through the early professional years. Recruitment, professional preparation, and professional orientation are the phases of a guidance program for science teachers. Knowledge, creativity, skill in communication, and devotion to a high and essential calling of teaching science are its aims. Science teachers, in particular, share in the responsibility for perpetuating their kind. Their opportunities for counseling and for service are indeed many.

*"Students in junior high [possess] an eagerness for knowing which simply cries out for understanding and encouragement—a true opportunity for guidance."—Badley.*

# *The* Early Guidance *of* Scientific Interest

*By* TED BADLEY

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ALL TEACHING is guidance, of course. The elementary teacher who uses a rounded pebble brought in by a child as the starting point for dramatizing the water-erosion-conservation concept is arousing and directing interest—doing guidance in a broad, general way. So is the teacher who awakens a scientific interest in lightning, magnets, or bugs.

However, a more specialized type of guidance begins at the junior high school. Here the science teacher has a responsibility to:

(1) work with available guidance specialists;

(2) become familiar with and use the theory and practices of modern guidance in a rudimentary form at least.

Students in junior high (roughly ages 11 to 14) are passing through one of the most formative periods of their lives. Interests and receptivity run high. New and exciting horizons are being discovered. There is an eagerness for knowing which simply cries out for understanding and encouragement—true opportunity for guidance.

This is the age of the inveterate collector: rocks, stamps, seals and labels, insects, shells, beetles, leaves, etc. It is the age of the explorer par excellence. Interest in the universe—astronomy—aviation—plant and animal life—the scientific aspects of the earth—will never be higher.

Don't waste this talent. Arouse it, shape it, channelize it, direct it. But don't ignore it. Recognize it for what it is—an awesome and beauteous interest in the universe of science.

### *How to Guide Science Interests*

The science teacher need not feel lost and confused when asked to be a guidance teacher. Behind the welter of professional jargon, conflicting theories and schools of thought, and the abundance of literature are three salient facts:

1. Useful guidance materials are readily available and easily applicable.

2. There is an abundance of material adaptable to the science field.

3. The keystone of guidance is, was, and always shall be a resourceful and understanding teacher, able and willing to recognize and meet student needs.

Guidance materials are available from a variety of sources, typical of which are Science Research Associates and American Education Publications.* The former publishes indivi-

* Science Research Associates, 57 W. Grand Ave., Chicago 10, Illinois; American Education Publications, 356 Washington St., Middletown, Conn.

dual booklets in which problems such as mental health, understanding sex, home life, hobbies, high school are surveyed. The latter publish shorter guidance features in their current periodicals, such as READ Magazine, which are especially prepared for schools.

The teacher will find these nontechnical, easily understandable materials simple to integrate into almost any program. They cover personal and social, educational, and vocational aspects of life adjustment. While not written specifically for the science teacher, they are easily adaptable to his needs.

Here are some proven ways of correlating guidance and science at the high school level: Study and get meaning from the natural environment. Arouse interests (published materials regularly received are an aid) by explaining the phenomena that pupils see, feel, taste, hear, and smell about them. This naturally includes plants, rocks, water, soil, animals, weather, etc.

Teachers in metropolitan centers, handicapped in some ways, will find themselves ahead in others. They may have to organize field trips in order to study at first hand the wonders of brook and meadow. But they are probably next door to the untold riches of natural history museums which rural areas lack.

Vicarious experiences such as museum visits rank next in importance to first-hand experiences in motivating scientific interests. Reading of course stands at the top of vicarious experiences.

The alert teacher recognizes individual differences in guiding reading interests. Use group guidance to teach the difference between what is authentic and worthwhile and what is trashy. But make allowances by helping Jim climb one trail, while Joe swings along another, and Judy skips along a third. Needless to say, the better a teacher knows his science literature and the better he knows his student's interests and abilities, the better he will be able to bring the two together in meaningful experiences.

Reading is sometimes the only means of exploring certain aspects of science—paleontology, for example. Therefore the teacher needs to avail himself of every available resource.

If a boy or girl shows an interest in the universe, steer him to good books such as *Stars for Sam* by W. M. Reed; *You and Space Travel* by J. Lewellen; *When the Stars Come Out* by R. H. Baker; or *Exploring the Universe* by J. Allen Hynek. If a pupils shows a flicker of interest in the earth, introduce him to the delights of such literature as: *All Around You* by J. Bendick; *Let's Go to the Brook* by H. E. Huntington; or *Lightning and Thunder* by H. Zim. Make use of periodicals such as *Current Science and Aviation, Natural History, Nature, The National Georgraphic,* and—yes—*Popular Mechanics.*

Scientific enthusiasm is easily channeled into worthwhile hobbies. It requires no magic to show students the superiority of a really scientific collection of insects to a heterogenous assortment of beer labels and advertising seals. So encourage worthwhile hobbies: stones, shells, grasses, flowers, leaves, wood, insects. Don't neglect photography.

Science clubs can be made worthwhile at the junior high level. Teach-

ers can draw on them for help in maintaining a "science corner" in the classroom or laboratory.

Too few teachers avail themselves of the numerous guidance opportunities inherent in their own communities. Even a so-called poor community will be found to contain a wealth of opportunities for guidance.

Take the occupations for example. A farmer is a scientist, living and working as he does with soil, plants and animals, fertilizers, and weather. If he be vocal, any farmer can broaden a child's horizons immeasurably.

Encourage him to demonstrate differences in soils and their effect on growth. If he is an orchardist, have him open up the relationship between fruits and insects, pests as well friends. A stock raiser can help make the rainfall-grass-animal-cycle alive and meaningful.

Start with a farmer or the county agent, but do not overlook the managers of the elevator, creamery, cooperative, or grocery. Arrange for the doctor, dentist, veterinarian and druggist to discuss their places in science. Tap all available industrial resources. Arrange visits to local plants whether they be small canneries or giant steel mills. Who knows what vistas the sight of an open hearth furnace or a brick kiln may open up.

Having had his scientific interest aroused and stimulated, a junior high school student should not be allowed to flounder blindly toward high school and or a job. Here is the point at which guidance specialists can be invaluable. Lacking such personnel, the science teacher can with commonsense and a modicum of knowledge aid students immeasurably.

Junior high school students are certainly not too young to begin thinking seriously about possible careers. There are interest and ability tests available to help them analyze themselves. There are scores of career books available.

Use classwide group guidance to study occupations, extensively rather than intensively. Study the big "job families." Outline the almost unlimited field for worthwhile careers in science. Point out the fallacy of entering an over-publicized, over-crowded field.

Give students individual aid in learning what to expect of high school and college. Orient them as to required courses and electives. Help them map out tentative courses for senior high school.

Lastly, encourage students to get actual work experience if possible. Part-time or summer employment, if wisely chosen, can prove highly beneficial. It may, and sometimes does, lead to a definite choice of a career.

*"What can be done for that group who have the potential ability, but who are unable to go on to college because of financial difficulties?"—Lee.*

# Guidance Toward Electronics Research *and* Development

*By* D. C. LEE

*Manager, Industrial Relations, Baltimore Division, Westinghouse Electric Corp. Baltimore, Maryland*

NOT TOO many years ago "electronics" was essentially synonymous with "radio," but today the word covers a much broader field, of which radio is a very small part. The old adage that "necessity is the mother of invention" perhaps has no truer application than in this field, as the pressure of wartime needs and present-day defense plans has caused a phenomenally rapid advancement to the point where "pushbutton warfare" is saving the lives of our soldiers in many ways. The time when the electronic "gadgets" and communications systems developed for the use of our armed forces will become an everyday part of our civilian world is not far off. Indeed, many of them are already so much a part of our lives that we take them for granted. The dreams of yesterday have become the facts of today.

Educators charged with the training and preparation of our young people of today for careers in technical fields will need to bring to their guidance work a whole new concept of what is meant by electronics engineering. In days when we sat around a crystal set or a one-tube radio set with the headphone pushed against our ears, the electronics engineer—or "radio" engineer—could rely on basic AC and DC theory in the development of simple oscillatory and rectification and even amplifier circuits. To make his life easy, there were handbooks which could be used in the design of coupling circuits, transformers, etc. The operation of the two and three element vacuum tube followed long established fundamentals. As time went on, additional elements were placed in the tubes, new control circuits were added, frequencies went up and up from wave lengths with their crests many meters apart to those only a few centimeters apart—and with these changes came new concepts of the functions that could be performed by electron tubes and new behavior of circuits and signals. With this new knowledge, new vistas of application came into range but with them came more problems, more theories, more research to be done. No longer is the electrical engineer's handbook the answer to the questions, nor any other handbook. Data for handbooks in the field of what we now know as electronics is just being collected and cannot be published for years to come as it becomes obsolete so rapidly.

What, then, do we mean by an "electronics engineer" today? He is not an electrical engineer. He is not a mechanical engineer. He is an entirely new type of engineer, rquiring special-

ized training which draws from many fields. He is versed in the fundamentals of electricity. He knows mechanical motions and stresses. He is familiar with chemical action and reactions. He is a mathematician of the highest degree. He is a physicist, an economist, and a writer. At the present stage in the development of electronics, all these different kinds of knowledge are so inter-related that the specialist in each field cannot handle the problems that arise. It becomes apparent that a high school education alone does not equip the student to perform any really technical work in the field of electronics, and that to attain a position in research and development he must have at least an undergraduate degree. To advance in their chosen field, almost all electronics engineers must have further work at the graduate level to enable them to handle the constantly changing problems that will confront them. Students may equip themselves to some degree for responsible technical positions in electronics by education available at the junior college level or in correspondence or residence courses in a number of specialty schools. Generally speaking, however, the most useful training is that to be acquired through colleges and universities.

It is impractical to expect the youth of this generation to forego the privilege of earning an income for a sufficient span of years to enable them to get the broad education so essential to a complete career in electronics. In fact, most students reach the point relatively early in life where they assume voluntarily or involuntarily the financial responsibility for at least some portion of the support of their families. Many do not have the financial means of obtaining advanced education and the various testing and guidance programs throughout the high schools have revealed that a great number of these students have potential abilities equal to those in more privileged economic groups. For these potential abilities not to be developed is a serious waste of manpower.

From the point of view of those of us in industry charged with obtaining personnel qualified for the various phases of electronics, the problem we pose to you who are educators has several aspects. First, can you through your guidance programs pick out those students who have the interest and the ability to pursue a career in a technical field such as electronics, and encourage them to continue their studies along these lines? Second, what can be done for that group who have the potential ability, but who are unable to go to college because of financial difficulties? Third, how can it be arranged so that the group who have completed their undergraduate degree can go on with their graduate program and still hold down a job?

The shortage of engineering personnel has been well publicized, and it is quite safe to predict that the need for qualified engineering personnel in the electronics industry is going to continue for a sufficient length of time to warrant an all-out program to insure that we have enough prospective trained engineering personnel in the "pipeline" to fill future requirements. Cooperative courses do not appear to be the answer, if the enrollment in programs of this nature in many universities and colleges is any criteria. Other plans of alternate work and study have been tried by individuals with questionable success. Recognizing the tremendous need for trained people, Westinghouse has for many years offered a

number of scholarships through the National Science Talent Search and by direct competitive examination. The number of applicants for these scholarships is an indication of the great amount of interest in further education which cannot be pursued except by a scholarship. The quality of the results of the competitive tests of even the non-winners is an indication of the potential ability of these people.

In an effort to reach the group of students who could not go beyond high school without financial assistance, Westinghouse with the cooperation of The Johns Hopkins University announced in April, 1952, a program in the Baltimore area whereby thirty high school graduates each would be given a part-time job working thirty-two hours a week in one of the electronic plants in this area, and would attend The Johns Hopkins University in the days and evenings. The curriculum covers only engineering subjects leading to a B. S. degree, and can be completed in from 36 to 38 months, at which time the student will be awarded a Certificate in Electrical Engineering by the University. All work done for this certificate may be credited towards the B. S. degree, giving a total of 87 credits or the equivalent of approximately two and a half years of college work. Upon satisfactory completion of each course, Westinghouse refunds one half the tuition and upon satisfactory completion of the whole program the other half is refunded. For those who cannot advance their tuition, loans are arranged with a payroll deduction plan. While on this program, the work assignments of each student are coordinated with his educational progress so that by the time he has completed this program he should be performing responsible work in the field of electronics development and design, with commensurate increases in his rate of pay.

It is unfortunate that to enable a student to complete this program in this period of time all of the so-called "humanities" are omitted. Probably no one realizes more than we do the importance of this phase of a sound education. We feel, however, that if we can fit these students to hold down responsible technical positions with a corresponding improvement in their financial circumstances, they will be better able and better motivated to continue their work towards their degree so that they can advance more rapidly to positions of higher responsibility.

In addition to the program with The Johns Hopkins University, under special arrangements with several universities Westinghouse has for many years encouraged its engineers to work towards graduate degrees at the Master's and Doctorate levels by refunding one half the tuition upon the satisfactory completion of each course taken for graduate credit, with the other half to be refunded upon the conferring of the degree. The acquiring of the necessary training and ability to handle work in research and development in the broad field of electronics does not come easy. But for the student who is willing to devote the time to the necessary study to qualify him to enter this extremely interesting and wide-open field, we have tried to remove the financial barriers as much as possible by providing the opportunity to earn an income with which to discharge his responsibilities and at the same time to attain his educational goal. We believe that the end results are well worth the effort and money expended—both on his part and on ours.

*A teacher may urge the better students, in high school science classes, in these words of Chapter IV, "Your Opportunities in Science." Reprinted with permission of the National Association of Manufacturers, New York City.*

# Good Advice

*Develop Your "Success Qualities"*

THE MORE of the following personal characteristics you can develop, the farther you are likely to go in science. You can strengthen them in yourself by a little daily effort until they become habitual.

1. Reliability: Months of time, thousands of dollars, can be lost through somebody's slip-up—an incorrect instrument reading, a few minutes' delay in removing a test specimen from a flame, the incorrect food dosage for a laboratory animal.

*Set yourself a daily schedule to get in the habit of doing things on time. Volunteer for committees and offices to get practice in carrying out assignments faithfully. Double check every task to make sure you've overlooked nothing.*

2. Patience: A scientist said, "All research work is 99.9% failure—but if you succeed once, you are in!"

*Stifle your impatience when things go wrong, when a member of your family seems to be getting on your nerves, when a friend is slow to grasp your point of view in a discussion. Don't let obstacles discourage you. Don't be a quitter!*

3. Cooperation: The successful science worker is a member of a tightly knit team. The snob, the big-shot, the glory-stealer get in the way of teamwork.

*Mix with people. Join clubs, church groups. In your family, accept responsiblity for shopping, fixing things, gardening, etc. Quell any tendency toward arrogance, egotism, bullying.*

4. Objectivity: To a scientist, the truth is what counts, not what anybody, including the scientist himself, thinks the truth ought to be. He separates himself, his likes and dislikes, his emotions and ambitions, from the problem at hand. When his "pet ideas" don't work out, he drops them promptly.

*Make a list of your strongest opinions, then set down every possible argument in favor of the opposite opinion. You will find few "open and shut" cases. Listen to both sides of any debate with an open mind. Refrain from coming to snap decisions about people, books, ideas. Admit it openly when you are in the wrong.*

5. Straight Thinking: A well-known scientist remarked, "Research is just a method of intelligent planning." The scientist thinks logically, mathematically. He moves straight toward his goal. His mind can be described this way: "No waste, no fat, no flabbiness."

*Take as many courses as you can in mathematics, geometry, algebra, logic. Develop hobbies like chess that train you in thinking ahead. Don't go about things in a catch-as-catch-can but plan ahead.*

6. Curiosity: Electrical genius Charles P. Steinmetz remarked, "No

man really becomes a fool until he stops asking questions."

*Make a list of things you are curious about—how mechanical gadgets work, for instance, and what's behind natural phenomena like volcanoes and storms. When a question arouses your curiosity, do not drop it until you track down the answer. As you learn more, you'll find yourself asking more questions, not fewer!*

7. Practical Imagination: Nobody ever saw electricity. No man has seen an atom or electron. But scientists imagined a flow of electrical current and atomic structure. Their imagination resulted in theories which actually worked out.

*Examine a set of blueprints for a machine or house and try to imagine the completed result. Try to picture what the inside of an automobile engine cylinder looks like at the moment of ignition; what life might be like on Mars; what radio waves would look like if they were visible. Train yourself to think boldly and logically about solutions to the problems still vexing mankind.*

8. Effective Expression: Scientists often make written reports to superiors, and submit articles to scientific journals. Sometimes they speak before staff conferences, scientific groups, or societies.

*Training in writing and speaking helps you to organize your thinking effectively. Get all you can out of grammar, composition and literature courses. Practice public speaking. Take pride in your letters to friends, instead of dashing them off. Read well-written books.*

9. Humility: Sir Isaac Newton's discovery of the Law of Gravitation made his world famous. Humbly, he said, "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me." The successul scientist knows that there is much he does not know so he keeps learning!

*Always keep learning! Regardless of your chosen specialty, learn about other sciences and other subjects like languages, art, business. Knowledge will come in handy for you as it did for the physicist who now heads up chemical research for his company, for the engineer who became an industrial designer for the scientist who became a corporation president.*

*Get an advanced college degree if possible, as more and more young people are doing. In 1920 only 280 Ph.D. degrees were awarded in the sciences. Now, that number is swiftly approaching 4,000 a year!*

*If you must get a daytime job, sign up for college courses at night, attend evening sessions at trade schools, technical schools, YMCA's, adult education classes. Take full advantage of any educational opportunities offered by your employer.*

*Your growing store of scientific and technical knowledge will help you get a good scientific job and advance in it. And never feel that you know all there is to know! Remember what Publilius Syrus said back in ancient Rome, "It is only the ignorant who despise education!"*

*Scientists Shape the Future!*

HUMAN knowledge and progress have come a long way since primitive witch doctors tried to control natural forces by offering cruel sacrifices.

Is progress finally slowing down? This claim has been made for many years. Back in 1844, U. S. Patent Commissioner Ellsworth said, "The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end." Clearly, he was wrong.

He was wrong because discovery leads to discovery; knowledge opens the gates to more knowledge. The tempo of scientific progress beats faster and faster, making possible further enlightenment and a new age of plenty.

The scientist cannot guarantee that his contributions will always be used for noble purposes. He cannot answer for the misuse of scientific discoveries by brutal dictators who would enslave the human race. But, he can supply the "bricks and mortar" for building a better world—and the defenses for keeping it that way.

"There is a great voice in the world today, the voice of science and technology." said Robert Patterson. "Never until today has it spoken with such authority. Never until today has it been listened to with such hope. And in no country in the world has its voice been as eloquent as in our own."

Will *you* become a frontiersman of the future—a scientist?

Will *you* be among those who see and plan and build—beyond the horizon?

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